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THE USE OF MODELS FOR STUDYING THE CIRCULATION IN GLASS TANKS*

By Edgar Buckingham

Abstract

The conditions that must be satisfied in a model experiment, in order to ensure that the circulation at the liquid in the model shall be similar to that of the molten glass in a full-sized tank, are deduced from the general theory of models, by the aid of several simplifying assumptions.

A discussion of the conditions shows that it will probably, though not certainly, be impracticable to satisfy all of them; and the discussion serves as a warning against the premature acceptance of conclusions from model experiments in which the required conditions were not satisfied.

I. Introduction

The circulation of liquid glass in a tank furnace may be imitated, qualitatively, by experimenting on a small model of the tank at such moderate temperatures as will admit of using some ordinary liquid to represent the molten glass. If all the circumstances of the model experiment could be suitably arranged and controlled, the imitation might be made quantitative, and observations on the behavior of the liquid in the model would then give definite and reliable information about what happens in full-scale operation. We propose to inquire into the conditions that would have to be satisfied in the model experiment in order to achieve this result.

The problem is altogether unmanageable unless we idealize it considerably by making simplifying assumptions, some of which are only rough approximations to reality. The greatest difficulties occur in connection with the choice of a model liquid, for the thermal and mechanical properties of this liquid must be related in certain definite ways to the corresponding properties of the molten glass, and it is doubtful whether any satisfactory liquid can be found or made up. But assuming that a suitable liquid can be obtained and accepting such other assumptions as seem unavoidable, we may attempt to find out how the model experiments ought to be conducted.

II. Similarity of Circulation

In the full-sized tank, let O_0 be some fixed point on the free surface of the molten glass, *e.g.*, the center of the refining end, and let P_0 be a fixed point anywhere in the body of the liquid.

The surface speed, S_0, can be found from observations on floats; but if the values of v_0, δ_0, and ϵ_0 are to be found, it must be by inference from observations on the model, because the point, P_0, is inaccessible to measuring instruments or to visual observation.

S_0 = speed of flow at O_0.
v_0 = speed of flow at P_0.
δ_0 = angle between velocity at P_0 and the vertical.
ϵ_0 = angle between this velocity and horizontal median line of tank.

In the model, let O_1 and P_1 be the points that correspond, geometrically, to O_0 and P_0; and let S_1, v_1, δ_1, and ϵ_1 have the same meanings, *mutatis mutandis*, as S_0, v_0, δ_0, and ϵ_0. Then, by saying that the circulation in the model is "similar" to that in the large tank, we shall mean that

$$\delta_1 = \delta_0; \quad \epsilon_1 = \epsilon_0; \quad \text{and } \frac{v_1}{S_1} = \frac{v_0}{S_0} \tag{1}$$

for all positions of the point, P_0.

If the model experiment can be so arranged that this similarity subsists, observations of δ_1 and ϵ_1 at points in the model liquid will give the values of δ_0 and ϵ_0 at the geometrically corresponding points in the liquid glass; and observations of S_1 and v_1, together with observations of S_0 in the large tank, will give the values of v_0, so that we shall then know the speed and direction of motion of the glass at points below the surface where they can not be observed directly.

If a model experiment is to serve this purpose, it must evidently be so devised that it is possible to determine the speed and direction of the flow at points in the body of the liquid. How this is to be done will not be discussed here; we shall assume that it can be done and pass on.

III. Assumptions Relating to the Liquid

(*a*) The circulation of the molten glass, or the "velocity field" in the large tank, depends on certain mechanical and thermal properties of the glass, and the circulation in the model depends on the corresponding properties of the model liquid. These properties vary with temperature, some

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more than others, and in any complete discussion of the relative behavior of two liquids in regions of nonuniform temperature it would be necessary to take account of the variations in question. We shall *assume*, however, that the properties of the glass that influence its circulation may be adequately specified by stating their values at some mean temperature, and we shall make the same assumption with regard to the model liquid.

In the case of the glass, the assumption is equivalent to assuming that if a liquid could be found that had, throughout the range of temperature to which the glass is subject, the same properties as the glass has at a certain fixed, mean temperature and if the glass were replaced by this liquid, the substituted liquid would circulate in the same way as the molten glass actually circulates. Similarly with respect to the model liquid. The assumptions may be only roughly true, especially for the glass, but they are indispensable simplifications.

(*b*) In the melting end of the tank, the glass is heated, partly by contact with hot gases and partly by radiation from the roof; and in the refining end, where the roof is cooler, the glass may be losing heat by radiation to the roof. In either case, the direct effect of radiation on the temperature of the glass is probably limited to a thin surface layer, for it seems probable that molten glass is very opaque to the kind of radiation involved.

We shall *assume* that the glass is so opaque that the temperatures at points in the body of the liquid below the surface are not appreciably affected by direct radiation but only by conduction and convection. So far as this is true, the convection currents that accompany the space variations of temperature in the body of the liquid will not depend on the means by which a particular distribution of temperature is maintained in the surface layer but only on what that distribution is.

(*c*) The viscosity of liquid glass is very high (of the order of 10,000 times the viscosity of water at room temperature) and the speeds of circulation are low; hence the inertia forces are small in comparison with the viscous forces. We shall *assume* that the inertia forces are of negligible importance.

This assumption seems quite safe. It is advantageous in applying dimensional reasoning to model experiments, as we are about to do, for it authorizes us to ignore the existence of Newton's second law of motion and to use an arbitrary fundamental unit of force instead of a unit derived from the units of mass, length, and time.

(*d*) There would be a further advantage in ignoring the fact of the equivalence of work and heat and using an arbitrary fundamental unit of quantity of heat. Whether this is permissible depends on whether the amounts of heat produced by dissipation of the work done by gravity against viscous resistances are of any importance in comparison with the amounts moved from place to place by conduction and convection. For if they are not, the distribution of temperature throughout the body of the liquid, or the "temperature field," will be sensibly the same as if the dissipated work were simply annihilated.

In view of the high value of the mechanical equivalent of heat, it seems unlikely that the heat of dissipation is of appreciable importance; and if this surmise is correct, the fact that work can be dissipated into heat, with a fixed conversion ratio, has no bearing on the operation of a glass tank and may be disregarded. We shall *assume* that this is permissible, and we shall therefore use an independent fundamental unit of heat in expressing the dimensions of specific heat and thermal conductivity.

IV. Postulates Concerning Construction of the Model

(*a*) The shape of the model tank, including the thickness of the walls and their internal roughness, is to be geometrically similar to that of the large tank; and the depth of the liquid is to be relatively the same in both.

The term "walls" is to be understood as referring to the floor of the tank as well as the sides, but not to the roof or to parts of the sides above the level of the liquid surface.

(*b*) If the thermal conductivity of the walls of the large tank is the same everywhere, the model may be built of a single, uniform material. Otherwise, the material of the model is to be varied from point to point, in such a way that its conductivity at each point bears a fixed ratio to the conductivity at the corresponding point on the large tank. What this ratio must be need not be specified until later.

We may describe this requirement by saying that the distribution of thermal conductivity in

the walls of the model is to be "similar" to that in the walls of the large tank; or that when we pass from the large tank to the model, the distribution of conductivity is to remain "similar to itself."

V. Heating and Cooling of the Model

Part of the heat given to the glass in the melting end of the tank is used in heating and melting newly introduced, cold material, and part is carried to the walls by convection and escapes to the outside air by conduction through them. Both parts depend on the fact that the glass is hotter than the air, and steady operation depends on the maintenance of this excess of temperature. Hence, in arranging a model experiment to imitate the temperature field and the accompanying circulation in the large tank, it is necessary to provide for some sort of similarity as to differences of temperature: (*a*) between the free surface of the liquid and the outside air and (*b*) between the outer surface of the walls and the air in contact with them.

(*a*) The surface of the liquid in the melting end of the model tank is to be heated by contact with jets of hot air. Heating by radiation from a heated roof, or from electric heaters placed over the surface of the liquid, would doubtless be more convenient. But to furnish enough heat would require a high radiator temperature and, unless the liquid were very opaque, this high-temperature radiation would penetrate to the deeper layers and heat them directly. This would not be a satisfactory imitation of the manner in which we have assumed the heating to take place in the full-sized furnace.

The heating is to be so arranged that the distribution of temperature over the surface of the model liquid imitates, and is similar to, the distribution over the surface of the molten glass; and before this adjustment can be made, the temperature of the surface of the glass must have been measured at a considerable number of points, so that we may know what we have to imitate. Such measurements are not easy to make; but without discussing the obvious experimental difficulties, we shall suppose them to have been surmounted and shall proceed to consider how the term "similar" is to be understood in this connection.

In the case of the full-sized tank, let

t_0 = surface temperature of glass at any point, P_0.
m_0 = mean temperature of whole surface.
a_0 = mean temperature of outside air.
$\Delta_0 = m_0 - a_0$.

Then the distribution of temperature that is to be imitated may be described by stating the constant values of a_0 and Δ_0 and by stating the values of $(m_0 - t_0)/\Delta_0$ for all positions of the point, P_0.

Turning to the model, let the corresponding quantities be denoted by t_1, m_1, a_1, and Δ_1, $-t_1$ referring to the point, P_1, which corresponds, geometrically, to P_0. The distribution of temperature over the surface of the model liquid may be described, as for the molten glass, by stating the values of a_1, Δ_1, and $(m_1 - t_1)/\Delta_1$.

If the heating of the model is so arranged that the equation

$$\frac{m_1 - t_1}{\Delta_1} = \frac{m_0 - t_0}{\Delta_0} \tag{2}$$

is satisfied for all pairs of corresponding points, P_0 and P_1, we shall say, as a matter of definition, that the distributions of temperature are similar; and we *postulate*, as one of the conditions to be observed in arranging a model experiment, that the surface of the model liquid shall be heated in such a way as to produce this temperature similarity between the model and the large tank.

(*b*) The temperature of the outside surface of the walls of the model must also be attended to and specified because it influences the rate of conduction through the walls. Let e_0 be the temperature at any point on the walls of the large tank and let e_1 be the temperature at the corresponding point on the model. Then if the values of e_1 are so adjusted that

$$\frac{e_1 - a_1}{\Delta_1} = \frac{e_0 - a_0}{\Delta_0} \tag{3}$$

for all pairs of corresponding points, we shall describe this adjustment by saying that the distribution of temperature on the outside surface of the model is similar to that on the outside of the large tank.

As a second temperature condition, we *postulate* that this similarity shall be maintained. There should be no serious difficulty in satisfying this requirement, for the values of e_0 are readily accessible to measurement and those of e_1 can be regulated by blowing air on the model.

VI. The Independent Variables

The configuration and speed of the circulation in a tank of given shape, whether large or small, are affected by various circumstances. We want

now, if possible, to make up a list of measurable quantities of which we can say, with confidence, that when their values are all fixed, the circulation is determinate, but that if any one of them were varied, independently of the others, the circulation would, or might, be altered. We start by considering a steady state of operation of the glass tank, with a known outside air temperature and a known distribution of temperature over the free surface of the liquid and the outside of the walls.

The existing steady circulation might be altered by changing the rate of working or, alternatively, by changing the composition of the liquid so as to vary its mechanical and thermal properties. Hydrostatic pressure gradients in the liquid are the immediate cause of the circulation and, other things being equal, they are proportional to the intensity of gravity. The value of g is constant, at any one place, but if it were to vary, the motion of the liquid would be affected; and the fact that g has a particular constant value, rather than some other, is one of the essential factors in determining the motion. Hence g must be included in our list of quantities, along with the rate of working and the properties of the liquid.

To go on to another possible variation of the working conditions, we might alter the circulation by changing the value of Δ and, at the same time, readjusting the applied heating and cooling so as to keep all values of $(m - t)/\Delta$ and of $(e-a)/\Delta$ unchanged and thus keep the temperature distribution on the surface of the liquid and the outside of the walls similar to itself during the change in Δ. Since it is only differences of temperature, and not absolute values, that influence the circulation, it is not essential that the air temperature, a, should remain constant while Δ is being changed. For if the new temperature distribution is similar to the old, the new differences will be completely determined by the new value of Δ, and the new steady state will be determinate.

This is as far as we can go with a particular tank, while still preserving temperature similarity. But although we can not actually change the properties of a given tank, it is evident that if we could change the mean conductivity of its walls the circulation would be affected. For the rate of escape of heat through the walls would be altered, and this would alter the temperature gradients in the liquid and the accompanying convection currents. Thus although the conductivity of the walls of a given tank is fixed, the mean conductivity has to be included in the proposed list of quantities, just as g has to be.

Finally, we might, in imagination, vary the size of the tank independently of the other quantities mentioned. This is, in substance, what we do when we turn from the original tank to a model of different size.

So long as the conditions postulated in Sections IV and V with respect to the construction and heating of models are observed, it does not appear that variations of any further quantities would have any appreciable effect on the circulation of liquid in a tank of the given shape, whatever its size. Hence, if nothing of serious importance has been overlooked, and if assumptions (a) and (b) of Section III are approximately true, it may be concluded that the circulation depends upon, and is determined by, the values of the ten quantities in the following list; with the proviso, however, that variations in some of them may, in practice, have so little effect on the circulation that these quantities might as well have been omitted from the list.

Symbol	Description of quantity	Dimensions
D	= linear dimension of tank	l
Δ	= mean excess of temperature of surface of liquid over outside air	θ
M	= time rate of withdrawal of mass	mt^{-1}
g	= intensity of gravity (force/unit mass)	fm^{-1}
λ'	= mean thermal conductivity of tank walls	$hl^{-1}t^{-1}\theta^{-1}$
ρ	= density of liquid	ml^{-3}
μ	= viscosity of liquid	$fl^{-2}t$
λ	= thermal conductivity of liquid	$hl^{-1}t^{-1}\theta^{-1}$
C	= specific heat of liquid	$hm^{-1}\theta^{-1}$
β	= coefficient of expansion of liquid	θ^{-1}

In accordance with assumptions (c) and (d) of Section III, the dimensions of the quantities are stated in terms of the six fundamental units, mass $[m]$, length $[l]$, time $[t]$, temperature $[\theta]$, force $[f]$, and quantity of heat $[h]$.

Because of the rôle they are to play, these ten quantities will be referred to as "the independent variables," in spite of the fact that they can not all be varied independently and arbitrarily and that g can not be varied at all, at any one place.

The last five represent all the properties of the liquid that need be taken into account, if assumptions (a) and (b) of Section III are accepted. As will be seen presently, the conditions to which even these five quantities are subject impose such restrictions on the values of the properties of the liquid to be used in the model that the discovery of a suitable liquid seems highly im-

probable. And any attempt to dispense with the assumptions would make matters still worse.

VII. Conditions for Similarity of Circulation

From this point onward, the following points are to be understood, without further mention:

(*a*) The shape of the tank and the distribution of conductivity in its walls are known.

(*b*) The distribution of temperature, over the free surface of the liquid and over the outside surface of the walls, is known for some particular steady state of operation.

(*c*) During any variations of size (D), wall conductivity (λ'), or intensity of heating (Δ), the conditions postulated in Sections IV and V with respect to the construction and heating of models are constantly satisfied. And it may be noted here that, although it has been convenient to refer to the original tank filled with liquid glass as the "large" tank, there is, in principle, no reason why the model should not be larger than its original. For any two geometrically similar bodies or structures may be regarded as models of each other.

In order to ensure similarity of circulation, in the sense of Section II, the simultaneous variations of the independent variables must satisfy certain conditions, and we have to find out what these conditions are.

Considering the velocity at any point in the liquid, let the direction angles, δ and ϵ, and the speed ratio, v/S, be defined as in Section II. Then if the independent variables listed above are necessary and sufficient to determine the circulation, there must be some equation connecting the value of δ with the values of the independent variables; and the same must be true of ϵ and v/S.

Let the equation for δ be represented by

$$\delta = F(D, \Delta, M, g, \lambda', \rho, \mu, \lambda, C, \beta). \tag{4}$$

The detailed form of the equation, or the form of the operator, F, will depend on the location of the point in question, and we have no means of knowing, *a priori*, what it may be; if we had, and if we knew the values of the ten variables, we could compute the value of δ without resorting to model experiments. But we do know that if the equation is to be generally correct, regardless of changes in the sizes of the fundamental units from which the other units are derived, all its terms must be of the same dimensions. And since δ is an angle, and an angle is measured by the ratio of two lengths and is therefore of zero dimensions, all the terms in the second member of equation (4) must also be of zero dimensions.

The variables therefore can not appear separately as independent arguments of the unknown function. They can appear only as elements of a number of combinations, each of which is dimensionless as a whole. Hence the equation must be in, or reducible to, the form

$$\delta = \varphi\,(\Pi_1, \Pi_2, \ldots \text{ etc.}) \tag{5}$$

in which the Π's are dimensionless products of powers of the original ten independent variables.

Since the form of the operator, φ, is unknown, the Π's on which it operates must, for generality, be as many independently variable combinations as can be made up; and the greatest possible number is the difference between the whole number of independent variables and the number of fundamental units in terms of which their dimensions are expressed. In this instance, the number is $10 - 6 = 4$, and equation (5) will contain 4 Π's; so we proceed to make up four different expressions of the form

$$\Pi = Q^{x_1} Q^{x_2} Q^{x_3} \ldots \text{ etc.} \tag{6}$$

in which the Q's are two or more of the independent variables and each of the four sets of exponents is determined in such a way that the dimensional equation of the Π in question reduces to

$$[\Pi] = [m^0 l^0 t^0 f^0 \theta^0 h^0] = [1]. \tag{7}$$

One of the numerous ways in which we might proceed is to let

$$\Pi = D^x \Delta^y M^z g^w \mu^v \lambda^w P \tag{8}$$

and set $P = \beta$, λ', C, ρ, successively. This will ensure that the four resulting Π's shall be independent of one another, for each will contain a P that does not appear in any of the others.

To illustrate the method of determining the exponents, let $P = C$. Substituting in equation (8), the dimensions of the seven variables, taken from the list above, we find that the dimensional equation of Π is

$$\begin{aligned}[\Pi_c] &= [l^x \cdot \theta^y \cdot m^z t^{-z} \cdot f^w m^{-w} \cdot f^v l^{-2v} \cdot \\ &\qquad h^w l^{-w} t^{-w} \theta^{-w} \cdot h m^{-1} \theta^{-1}] \\ &= [m^{z-w-1} \cdot l^{x-2v-w} \cdot t^{-z+v-w} \cdot f^{w+v} \cdot \theta^{y-w-1} \cdot h^{w+1}].\end{aligned}$$

And to make Π_c of zero dimensions with respect to each of the six fundamental units, we must make

$$\left.\begin{aligned} z - u - 1 &= 0 \\ x - 2v - w &= 0 \\ -z + v - w &= 0 \\ u + v &= 0 \\ y - w - 1 &= 0 \\ w + 1 &= 0 \end{aligned}\right\} \quad \text{or} \quad \left\{\begin{aligned} x &= -1 \\ y &= 0 \\ z &= 1 \\ u &= 0 \\ v &= 0 \\ w &= -1 \end{aligned}\right.$$

Inserting these exponents in equation (8), with $P = C$, we find that

$$\Pi_\epsilon = \frac{MC}{D\lambda}.$$

By the same sort of process, the other three Π's are found to be

$$\Pi_\beta = \Delta\beta; \quad \Pi_{\lambda'} = \frac{\lambda'}{\lambda}; \quad \Pi_\rho = D^2\rho\sqrt{\frac{g}{M\mu}}$$

and one of the possible forms of equation (5) is

$$\delta = \varphi\left(\Delta\beta, \frac{\lambda'}{\lambda}, D^2\rho\sqrt{\frac{g}{M\mu}}, \frac{MC}{D\lambda}\right). \tag{9}$$

By grouping the independent variables in other ways than the one indicated by equation (8), other sets of independent Π's might be obtained. Furthermore, after one or more Π's have been found, as many more as we please can be formed from them. For example, if Π_1 and Π_2 are dimensionless, $\Pi_1^m \times \Pi_2^n$ is also dimensionless, whatever the values of m and n. But however long a list of Π's we may have made up, not more than four of them will be independent; and if we pick out *any* four that are independently variable and assign numerical values to them, the numerical value of every one of the others will thereby be fixed. We may therefore replace the four Π's in equation (9) by any other four that we know to be independent; and so long as the form of the operator, φ, remains undetermined, the meaning of the equation will be unaffected by the change in its appearance.

For our present purpose, it will be convenient to replace Π_ρ in equation (9) by $\Pi_\rho^2 \times \Pi_\epsilon = D^3g\rho^2C/\mu\lambda$, and write the equation in the modified but equivalent form,

$$\delta = \psi\left(\Delta\beta, \frac{\lambda'}{\lambda}, D^3g\frac{\rho^2C}{\mu\lambda}, \frac{MC}{D\lambda}\right), \tag{10}$$

in which β, λ, C/λ, and $\rho^2C/\mu\lambda$ represent the properties of the liquid; D and λ' specify the size of the tank and the mean conductivity of its walls; and Δ and M describe the operating conditions.

Since the nature of the mathematical operations indicated by ψ remains undetermined, what equation (10) states is that the value of δ is completely determined by the values of the four independent expressions inside the parenthesis and depends on them in some definite manner, symbolized by $\psi(-)$, which is the same for the model and its liquid as for the full-sized tank and the molten glass but which is otherwise unknown.

Let values of the quantities that refer to the operation of the large tank be distinguished by subscript 0, and values that refer to the model experiment, by subscript 1.

Let us suppose that the model is so constructed and operated, and the model liquid so selected, that the equations

$$\left.\begin{aligned} &\Delta_1\beta_1 = \Delta_0\beta_0 && (a)\\ &\frac{\lambda_1'}{\lambda_1} = \frac{\lambda_0'}{\lambda_0} && (b)\\ &D_1^3\left(\frac{\rho^2C}{\mu\lambda}\right)_1 = D_0^3\left(\frac{\rho^2C}{\mu\lambda}\right)_0 && (c)\\ &\frac{M_1}{D_1}\left(\frac{C}{\lambda}\right)_1 = \frac{M_0}{D_0}\left(\frac{C}{\lambda}\right)_0 && (d) \end{aligned}\right\} \tag{11}$$

are satisfied. Then the numerical values of the operands of ψ will be the same for the model as for the large tank, and the results of the operation, ψ, will be the same, no matter what the form of ψ may be. Equation (10) must therefore give the same value of δ in both cases.

Since the angle, ϵ, and the speed ratio, v/S, are dimensionless, the course of reasoning followed with δ will lead to the same conclusions with respect to ϵ and v/S as are represented by equation (10) in the case of δ. Hence it follows that if the model experiment is so arranged that equations (11) are satisfied, we shall have

$$\delta_1 = \delta_0; \quad \epsilon_1 = \epsilon_0; \quad \frac{v_1}{S_1} = \frac{v_0}{S_0} \tag{12}$$

and the circulation in the model will be similar to that in the full-sized tank. Equations (11) therefore represent, or describe, the conditions for similarity of circulation.

As noted above, the four operands of ψ in equation (10) might equally well be replaced by any other four independent, dimensionless combinations of the original ten variables; and the four conditions for similarity of circulation would then differ in appearance from equations (11). But examination would show that they could be transformed into equations (11) and were therefore equivalent to them.

VIII. Remarks

All four of equations (11) involve properties of the molten glass, and before a model experiment can be arranged so as to satisfy the equations, the values of these properties must be known. A certain amount of information is available on the densities of molten glasses at various temperatures, as well as on viscosities and specific heats; but in view of the high temperatures in question, it is not surprising that the experimental data are few and not very accurate. Moreover, it may be

doubted whether any determinations of thermal conductivity have ever been attempted; the conductivity of liquids is hard to measure, even at ordinary temperatures. Nevertheless, we shall anticipate future possibilities by making the (at present, false) assumption that the values of β, λ, C, and $\rho^2 C/\mu\lambda$ are known for the glass under discussion, and we shall proceed on this assumption.

IX. Selection of the Model Liquid

Equation (11, *a*) requires that

$$\beta_1 = \frac{\Delta_0}{\Delta_1}\beta_0 \tag{13}$$

where β_0 is the mean coefficient of expansion of the glass over a range of perhaps 800° to 1500°C. In the large tank, Δ_0 may be of the order of 1400°, whereas very few ordinary liquids can be heated to 300°C without decomposing rapidly. Hence even if the air about the model is cooled to 0°C, the value of Δ_0/Δ_1 is not likely to be less than about 5; and this means that the coefficient of expansion of the model liquid must be at least five times that of the liquid glass.

It seems improbable that any liquid that can be used at temperatures approaching 300°C will have so high a coefficient of expansion; for liquids, such as acetone, that have high values of β, usually decompose at temperatures far below 300°C. To use a liquid of this sort would lower the possible value of Δ_1, thus increasing Δ_0/Δ_1 and accentuating the demand for a high value of β_1. Perhaps the most promising line of attack would be to attempt to make up a stable emulsion of air, or other gas, in a very viscous and heat-resistant liquid, such as a heavy cylinder oil. If the emulsion contained enough gas, it might have a sufficiently high coefficient of expansion to satisfy equation (11, *a*) or (13).

The selection of a particular liquid for use in the model fixes the values of λ_1, C_1, ρ_1, and μ_1 and these must be determined, if not already known.

X. Construction of the Model

After the model liquid has been decided on, the size of the model is no longer arbitrary. For equation (11, *c*) requires D_1 to satisfy the equation,

$$\frac{D_1}{D_0} = \left[\left(\frac{\rho^2 C}{\mu\lambda}\right)_0 \div \left(\frac{\rho^2 C}{\mu\lambda}\right)_1\right]^{1/3} \tag{14}$$

or

$$\frac{D_1}{D_0} = \left(\frac{\rho_0}{\rho_1}\right)^{2/3}\left(\frac{C_0}{C_1}\right)^{1/3}\left(\frac{\mu_1}{\mu_0}\right)^{1/3}\left(\frac{\lambda_1}{\lambda_0}\right)^{1/3} \tag{15}$$

The specific gravity of the molten glass will be more than 2.0 and no ordinary liquid is as dense as this, so that $(\rho_0/\rho_1)^{1/3}$ will certainly be greater than 1.0. Hence, if the conditions for similarity are to be satisfied by a small model, the product of the remaining three factors in equation (15) must be considerably less than 1.0.

It would be useless to speculate on the probable values of these factors. Even if a model liquid could be found to satisfy equation (11, *a*), it might turn out that the model had to be as large as the original or larger; and though experiments on such a scale might be possible, they would hardly be practicable.

Equation (11, *b*) represents the only other condition on the construction of the model: it should not present any great difficulty if the value of λ_0 were known.

XI. Rate of Flow through the Model

Equation (11, *d*), which represents the fourth condition for similarity, may be put into the form

$$\frac{M_1}{M_0} = \frac{D_1\lambda_1 C_0}{D_0\lambda_0 C_1} \tag{16}$$

Or, by equation (15),

$$\frac{M_1}{M_0} = \left[\left(\frac{C_0}{C_1}\right)^4\left(\frac{\lambda_1}{\lambda_0}\right)^4\left(\frac{\rho_0}{\rho_1}\right)^2\frac{\mu_1}{\mu_0}\right]^{1/3} \tag{17}$$

And since M_1 is freely adjustable, it can always be made to satisfy this equation if the values of the other quantities are known.

XII. Comments

The reader who has followed the foregoing developments will be inclined to ask: What value has an academic discussion of which the only apparent result is to show that reliable model experiments are impossible at present and would probably still be impracticable even if we had all the desired information about the properties of molten glass?

One answer to the question is that a general statement of the conditions for similarity of circulation serves as a warning against the premature acceptance of conclusions from model experiments in which the conditions were not all satisfied. Such conclusions may be correct, but there can be no certainty that the circulation of the molten glass is similar to the observed circulation of the liquid in the model until it has been shown that the neglected or violated conditions were, in reality, not essential.

Let us reëxamine Section VII. By accepting the assumptions of Section III, we were led to conclude that there is some definite relation, represented by equation (10), which is of the same form for a model that satisfies the postulates of Sections IV and V as for the original full-sized tank; and that there are analogous relations for ϵ and v/S, which might be represented by equations involving the same Π's as equation (10) but with ψ_1 and ψ_2 in place of ψ. From this it followed that if equations (11) are satisfied (and so far as the assumptions in Section III are approximately true), the circulation in the model will be similar to that in the large tank for all possible forms of the undetermined operators ψ, ψ_1, and ψ_2.

But it is conceivable that these unknown forms may be such that variations in the numerical value of some one of the Π's, perhaps more than one, have no appreciable effect on the numerical values of δ, ϵ, and v/S that would be obtained if the arithmetical operations indicated by the ψ's were known and could be carried out. In that event, the value of the Π in question is of no practical importance in determining the circulation; it will not be necessary to satisfy the corresponding one of equations (11); and one restriction on our freedom in arranging the model experiment will be absent. In other words, the conditions expressed by equations (11) will always be *sufficient* to ensure similarity of circulation, but in practice they may not always all be *necessary*.

To illustrate such a possibility, let us assume that variations of the absolute value of the density have no appreciable effect on the circulation. Then since ρ does not appear in equation (10) except as a factor of $D^3\rho^2g/\mu\lambda$, this Π may as well be omitted and we are relieved of the necessity of satisfying equation (11, *c*). This greatly simplifies the problem. For D_1 and D_0 now occur only in equation (11, *d*); and since M_1 can be adjusted at will, we are free to make the model of any convenient size. And after equations (11, *a*) and (11, *b*) have been satisfied, all that remains is to adjust M_1 in accordance with equation (16).

To decide whether the absolute value of the density is of so little importance as to justify this simplification requires a direct comparison of the flow in the model with the flow in the large tank; and no convincing answer to the question can be obtained except for corresponding points on the surfaces of the two liquids, because the velocities in the deeper layers of the molten glass can not be observed. If the model experiment has been arranged without regard to equation (11, *c*) but so as to satisfy the other three conditions, and if observation shows that the motion of the surface layer of the liquid glass is similar to the motion of the surface layer of the liquid in the model, this creates a strong presumption that the whole circulation is similar in the two cases. But it is only a presumption and not a certainty, for the forms of ψ, ψ_1, and ψ_2 depend on the location of the point to which they refer.

Analogous, tentative assumptions might be made with respect to the other Π's in equation (10), and if such experimental verification as is possible by observations of surface motions turned out favorably, corresponding simplifications in model procedure would presumably be justified. And although the prospect of obtaining reliable information from experiments on models of glass tanks seems very unpromising, it may prove to be not entirely hopeless.

XIII. Another Treatment of the Problem

Acceptance of assumptions (*c*) and (*d*) of Section III permitted us to use six fundamental units, and led to the $10 - 6 = 4$ conditions for similarity, expressed by equations (11). Although the assumptions seem quite safe, we may indicate, briefly, the result of dispensing with them and expressing all dimensions in the conventional manner, in terms of (m, l, t, θ).

The dimensional equations of the independent variables are

$$\begin{array}{llll} [D] = [l] & & [\rho] = [ml^{-3}] \\ [\Delta] = [\theta] & & [\mu] = [ml^{-1}t^{-1}] \\ [M] = [ml^{-1}] & & [\lambda] = [mlt^{-3}\theta^{-1}] \\ [g] = [lt^{-2}] & & [C] = [l^2t^{-2}\theta^{-1}] \\ [\lambda'] = [mlt^{-3}\theta^{-1}] & & [\beta] = [\theta^{-1}] \end{array}$$

The number of independent Π's is now $10 - 4 = 6$, and by methods like those that led to equation (10) we may get the equation

$$\delta = \psi'\left(\Delta\beta, \frac{\lambda'}{\lambda}, D^3g\frac{\rho^2C}{\mu\lambda}, \frac{MC}{D\lambda}, Dg\frac{\beta}{C}, \frac{\lambda}{\mu C}\right) \qquad (18)$$

which may be compared with equation (10) or

$$\delta = \psi\left(\Delta\beta, \frac{\lambda'}{\lambda}, D^3g\frac{\rho^2C}{\mu\lambda}, \frac{MC}{D\lambda}\right). \qquad (10)$$

The comparison shows that abandoning the two assumptions has brought in two new Π's and

that in order to ensure similarity of circulation it is now necessary to satisfy the equations

$$\left.\begin{aligned} D_1\left(\frac{\beta}{C}\right)_1 &= D_0\left(\frac{\beta}{C}\right)_0 \qquad (e)\\ \left(\frac{\lambda}{\mu C}\right)_1 &= \left(\frac{\lambda}{\mu C}\right)_0 \qquad (f)\end{aligned}\right\} \tag{11}$$

in addition to the four equations (11, *a*) to (11, *d*).

The third Π in equation (18) might be replaced by the product of the third and sixth, or

$$D^3g\frac{\rho^2 C}{\mu\lambda}\times\frac{\lambda}{\mu C}=D^3g\frac{\rho^2}{\mu^2} \tag{19}$$

which is slightly simpler in appearance. And the fourth Π might be replaced by the product of the fourth and sixth or

$$\frac{MC}{D\lambda}\times\frac{\lambda}{\mu C}=\frac{M}{D\mu} \tag{20}$$

which is also slightly simpler.

With these modifications, equation (18) takes the form

$$\delta=\psi'\left(\Delta\beta,\frac{\lambda'}{\lambda},D^3g\frac{\rho^2}{\mu^2},\frac{M}{D\mu},Dg\frac{\beta}{C},\frac{\lambda}{\mu C}\right) \tag{21}$$

and the six conditions needed to ensure similarity of circulation in the general case, where neither inertia forces nor viscous dissipation of work into heat can be neglected, may be expressed by the equations

$$\left.\begin{aligned} \Delta_1\beta_1 &= \Delta_0\beta_0 \qquad (a)\\ \frac{\lambda_1'}{\lambda_1} &= \frac{\lambda_0'}{\lambda_0} \qquad (b)\\ D_1^2\left(\frac{\rho}{\mu}\right)_1^2 &= D_0^2\left(\frac{\rho}{\mu}\right)_0^2 \qquad (c)\\ \frac{M_1}{D_1\mu_1} &= \frac{M_0}{D_0\mu_0} \qquad (d)\\ D_1\left(\frac{\beta}{C}\right)_1 &= D_0\left(\frac{\beta}{C}\right)_0 \qquad (e)\\ \left(\frac{\lambda}{\mu C}\right)_1 &= \left(\frac{\lambda}{\mu C}\right)_0 \qquad (f)\end{aligned}\right\} \tag{22}$$

Equations (22) are about as simple and perspicuous statements of the conditions for similarity as can be devised, but the third and fourth may be modified so as to be, perhaps, more familiar in appearance.

The third Π in equation (21) might be replaced by the product of the third and first, or

$$\frac{D^3g\rho^2\Delta\beta}{\mu^2}=G \tag{23}$$

which is known as the Grashof number; and equation (22, *c*) is equivalent to $G_1 = G_0$. But until it has been shown that the condition, $\Delta_1\beta_1 = \Delta_0\beta_0$, is unimportant, the employment of the Grashof number is a useless complication.

The fourth Π in equation (21) is equivalent to a Reynolds number.

Let A = smallest transverse section of tank.
v = mean longitudinal speed of flow through A.
$V = Av$ = rate of withdrawal of volume of liquid.

The shape of the tank being given, $A = nD^2$, where n is a numerical shape constant that depends on what linear dimension is represented by D. And since $M = V\rho$, we have

$$\frac{M}{D\mu}=\frac{V\rho}{D\mu}=\frac{Av\rho}{D\mu}=\frac{nD^2v\rho}{D\mu}=\frac{nDv\rho}{\mu}=R \tag{24}$$

and R is a Reynolds number. Equation (22, *d*) is therefore equivalent to $R_1 = R_0$.

The last Π in equation (21), or

$$\frac{\lambda}{\mu C}=S \tag{25}$$

is sometimes known as the Stanton number, or its reciprocal as the Prandtl number; so equation (22, *f*) might be abbreviated to $S_1 = S_0$.

Although this second treatment of the problem is more general than the earlier one, in that it dispenses with two assumptions, it is merely of academic interest. For beside the fact that the assumptions referred to seem quite safe, we now have six conditions to be satisfied; and the four of the earlier list were already embarrassingly many. It may also be noted, incidentally, that equations (22, *c*) and (22, *e*) are independent specifications of the scale ratio, D_1/D_0. They could not both be satisfied unless the properties of the model liquid satisfied the equation,

$$\frac{\mu_1^2\beta_1^3}{\rho_1^2C_1^3}=\frac{\mu_0^2\beta_0^3}{\rho_0^2C_0^3} \tag{26}$$

and it would be a happy accident indeed if a liquid selected, or made up, with the aim of satisfying equation (22, *a*) should also happen to satisfy equation (26) as well as (22, *f*).

XIV. Concluding Remarks

It was assumed in Section III (p. 1) that inertia forces are negligible and that heat of dissipation is negligible. In the first discussion of the problem of securing similarity of circulation, the adoption of these two assumptions enabled us to base the dimensional argument on the use of six fundamental units, and we were led to the 10 − 6 = 4 conditions expressed by equations (11) (p. 6).

When neither assumption was adopted, all of the dimensions had to be expressed in terms of only four fundamental units, as in Section XIII, and this led to the $10 - 4 = 6$ conditions expressed by equations (22).

Instead of either of these procedures, we might drop one of the assumptions and keep the other, using (m, l, t, θ, h) as fundamental units in the one case, and (m, l, t, θ, f), in the other. In either case, we should obtain $10 - 5 = 5$ conditions and two of them would be (or be equivalent to) $\Delta_1\beta_1 = \Delta_0\beta_0$ and $\lambda'_1/\lambda_1 = \lambda'_0/\lambda_0$. The dimensional method of reasoning, however, has been sufficiently illustrated, and any further discussion of these two additional forms of the problem would be superfluous.

National Bureau of Standards
Washington, D. C.

MICROSCOPIC STUDIES OF REBOILING PHENOMONA*

By D. S. Connelly and J. O. Lord

Abstract

Photomicrographs of enameled sheets at high temperatures, giving the different stages of the reboiling cycle and observations and deductions therefrom, are presented.

I. Introduction

Andrews[1] and Lord have shown, in motion picture films, the microscopic appearance of the surface of ground coats during the reboiling cycle.[2]

Andrews observed that the bubbles responsible for reboiling appeared to form underneath the enamel at or near the metal surface, from where they pushed their way to the enamel surface and finally broke.

For Lord's pictures, a special furnace was constructed in which the specimens could be observed through the microscope while they were being fired. The details of the construction of this furnace are described in this paper.

Extended study by means of this furnace and set-up has yielded more interesting points on reboiling, but the expensive motion pictures have been discontinued. A reflex camera with a focussing mirror and focal plane shutter kept the specimen under observation up to the instant of exposure of the photographic negative.

II. The Apparatus

(1) The Furnace

Figure 1 shows, in diagrammatic form, the arrangement of the furnace, microscope, illuminating system, and camera.

The specimen is indicated at A, where it is supported on three steel prongs. These prongs are attached firmly to the movable bottom, C. This bottom may be lowered or raised for introduction into or removal of the specimen from the furnace. The post on which the bottom rests slides in the guides at E.

The furnace proper, B, consists of an Alundum heating chamber of about $2^1/_2$ inches inside diameter around which is wound the nichrome heating element, which in turn is surrounded by a mixture of china clay and firebrick grog. The whole is inclosed in high-temperature insulating brick. A chromel-alumel thermocouple enters the furnace close to the specimen, and temperatures are measured by a Leeds & Northrup portable potentiometer.

The top of the furnace is a piece of insulating brick about one inch thick, in which two holes of appropriate size and shape are cut for the illumination and observation of the specimen. Covering these holes is a polished clear silica glass plate, H, of high quality. For the further protection of the microscope, there is a water-cooled metal plate, D, with holes arranged to correspond with those in the top brick. The microscope is supported above this on a sheet of Transite board.

(2) The Microscope

The stage of the microscope, J, has been eliminated so that the tube and objective may be racked down close to the top of the furnace. The

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* Presented at the Annual Meeting, American Ceramic Society, Columbus, Ohio, March 31, 1936 (Enamel Division).

[1] A. I. Andrews, "Microscopic Observations of the Appearance of Enamels During Firing and Reboiling," *Bull. Amer. Ceram. Soc.*, **14** [1] 18–19 (1935).

[2] These films were shown at the Annual Meeting of the American Ceramic Society, Cincinnati, Ohio, February, 1934.

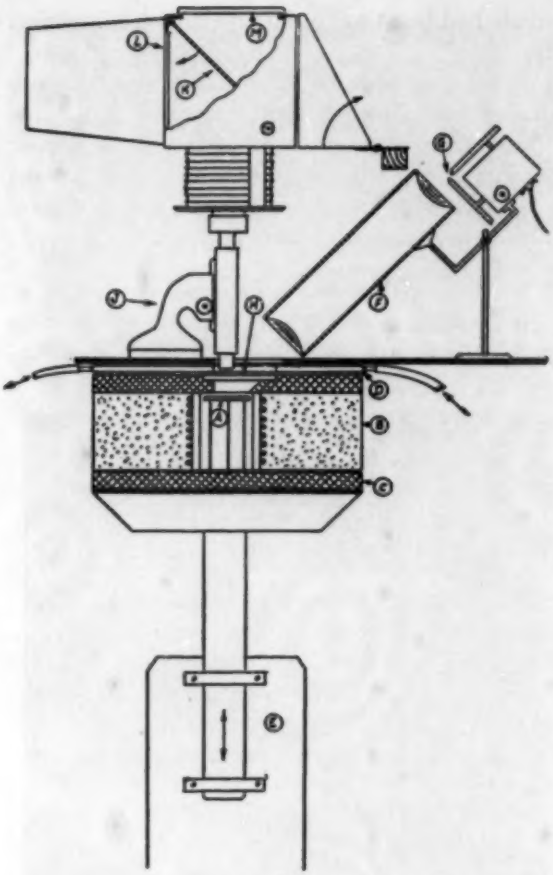

FIG. 1.

objective is a 42-millimeter Leitz Summar with iris diaphragm. The eyepiece, a 6-diameter Huygenian, was satisfactory for the work at hand.

(3) Illuminating System

To secure short exposures (particularly for the motion pictures), intense illumination was required. This was obtained by using a carbon arc lamp, *G*, and the two halves of a stereopticon condensing lens, *F*, spaced about two feet apart. It was found that this wide spacing gave a more brilliant image of the arc and at the same time a narrower pencil of rays than when the two lenses were close together. The narrow pencil of rays was necessary to avoid having to cut too large a hole in the top of the furnace. The light struck the specimen at about 35 degrees from the horizontal.

(4) Camera

The camera is a reflex type (similar to the Graflex). The image, through the microscope, is focussed on the ground glass, *L*, by means of the hinged mirror, *K*. The film is located at *M*. At the instant an exposure is made the mirror swings down against *L*.

(5) Specimens

The specimens are 2-inch diameter disks of No. 20 gage enameling iron stock. The material selected was known to reboil.

NOTE: The steel was cleaned and pickled as follows: Cleaner, 20 minutes at 199°F; water rinse 1 minute at 180°F; sulfuric acid 10 minutes at 170°F; water rinse 1 minute at 170°F; neutralizer 3 minutes at 180°F.

The enamel was a commercial cobalt ground coat. It was applied to the specimens by dipping. These were dried and given the first firing of about 4 minutes at 1600°F in a Westinghouse laboratory furnace.

NOTE: The enamel was ground in a laboratory ball mill to a fineness of 7 grams on 200-mesh from a 100-gram sample. Seven per cent Vallendar clay was used in the mill addition.

III. Visual Observations

Before any pictures were taken, the reboiling cycle was studied by watching the pieces through the microscope as they were fired. They were found to reboil consistently if the furnace was held at from 1600° to 1680°F. (The furnace actually dropped about 75° when the piece was put in.) Frequently there would be no reboiling below 1600°F. Time studies were made on the operation and numerous facts were noted.

The reboil started at intervals varying from 15 to 40 seconds after the piece was put in the furnace. For any given material the time was closely related to the temperature, *i.e.*, the higher the temperature, the shorter the time.

As explained by Andrews,[1] reboiling is manifested by a sudden appearance of brilliant flares of light on the enamel surface. These are due to reflection of the illuminating beam of light from the rounded surface of the large reboil bubbles. Repeated observations show that the reboil bubbles originate in the enamel as bumps or bulges that are many times larger than the ordinary bubbles scattered through the enamel. Many of the smaller bubbles are scattered about the surface of these large bulges. The gas that forms the bulge later seems to break through the lower, opaque part of the enamel layer and finally appears as an extra large ordinary bubble. The

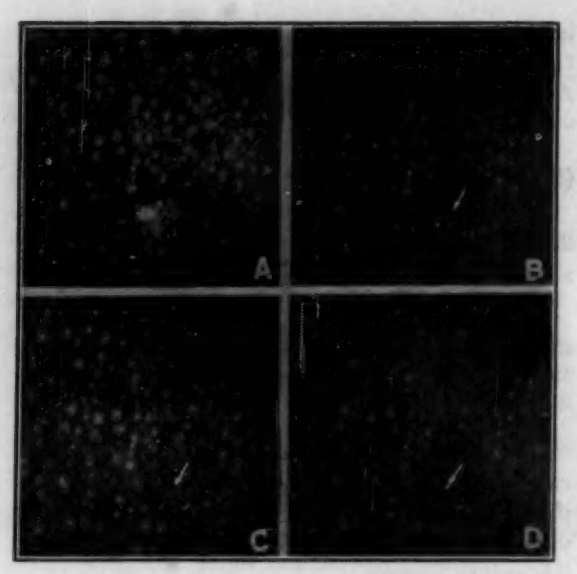

FIG. 2.

surface of this reboil bubble, however, is often cloudy compared to the bright surface of the ordinary bubbles.

Difficulties were encountered in determining visually the exact time at which the reboil bubble came to the surface and burst (as it was supposed to do). This was due to the fact that the distracting influence of the other bubbles, both reboil and ordinary, decoyed our attention from any particular bubble. The ordinary bubbles throughout the firing increase in size by breaking into each other and also frequently break and vanish at the surface. After a sufficient length of time most of the bubbles are eliminated from the enamel.

After many firings were checked, it became increasingly apparent that some of the reboil bubbles were not bursting at all. Furthermore, they actually became smaller as the firing time was extended. It was observed later that prior to the appearance of the flares of light the whole surface of the enamel became bulged and wrinkled, many of the bulges never showing flares or developing actual bubbles. This wrinkled appearance, moreover, occurred on pieces that did not reboil at all.

When a large reboil bubble broke at the surface it often seemed to expose the metal at the bottom of the crater which began to coat with oxide at once. The enamel flowing in from the sides filled this up quickly, dissolving the oxide as it did so, and the final appearance of the place where a bubble had burst was a dark, yellowish or greenish area.

Where any area of appreciable size was uncovered by enamel so that a layer of iron oxide formed, there was continuous action, bubbling, or foaming at the edge of the enamel where it was in contact with and dissolving the oxide. These bubbles were numerous and very small.

IV. Photomicrographs

In addition to constituting a record of these observations, the photomicrographs offered a

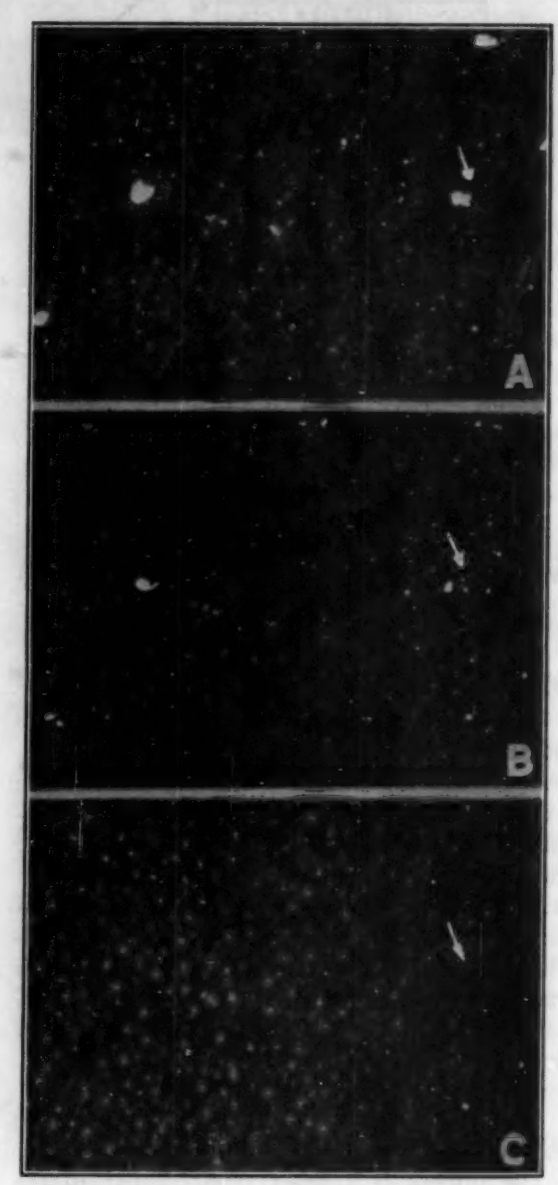

FIG. 3.

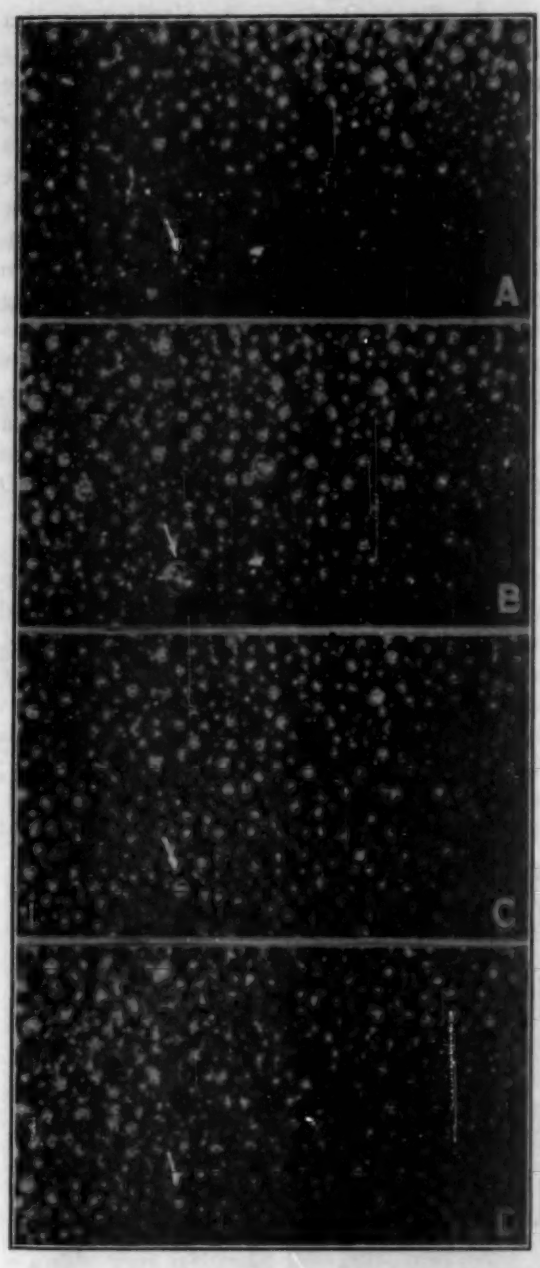

FIG. 4.

more accurate and leisurely means for comparing the appearance of the ground coat at different stages in the cycle. The action of the enamel was watched in the ground glass of the camera until such time as a feature of interest appeared; then the mirror of the camera was swung out of the way to make the exposure. The mirror was immediately returned to the 45-degree position and the action observed again until another feature of interest appeared, or until some predetermined time for another exposure. The magnification in the original photomicrographs is about 20 diameters.

Figures 3*A* and 6*A* show the wrinkling or bulging of the surface prior to the reboil. These photographs were taken after the reboil had started, but the wrinkled appearance had started some seconds earlier. Figures 2*A* and 6*A* show the large raised areas that are the locations of the reboil bubbles. The bubble that started in 2*A* appears in 2*B*, is much smaller in 2*C*, and in 2*D* has burst, leaving a discolored spot.

Figure 3*A* also shows the reboil flares of light and the wrinkled surface. The bubbles formed by the reboil appear while some of the flares still show in 3*B* and have become smaller or vanished in 3*C*.

EDITOR'S NOTE: No unusual reboiling appears in Fig. 3.

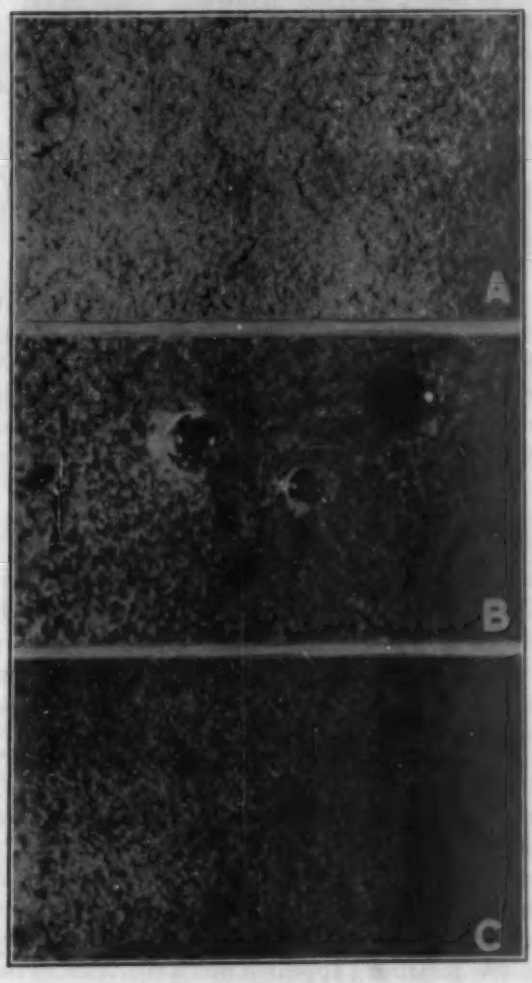

FIG. 5.

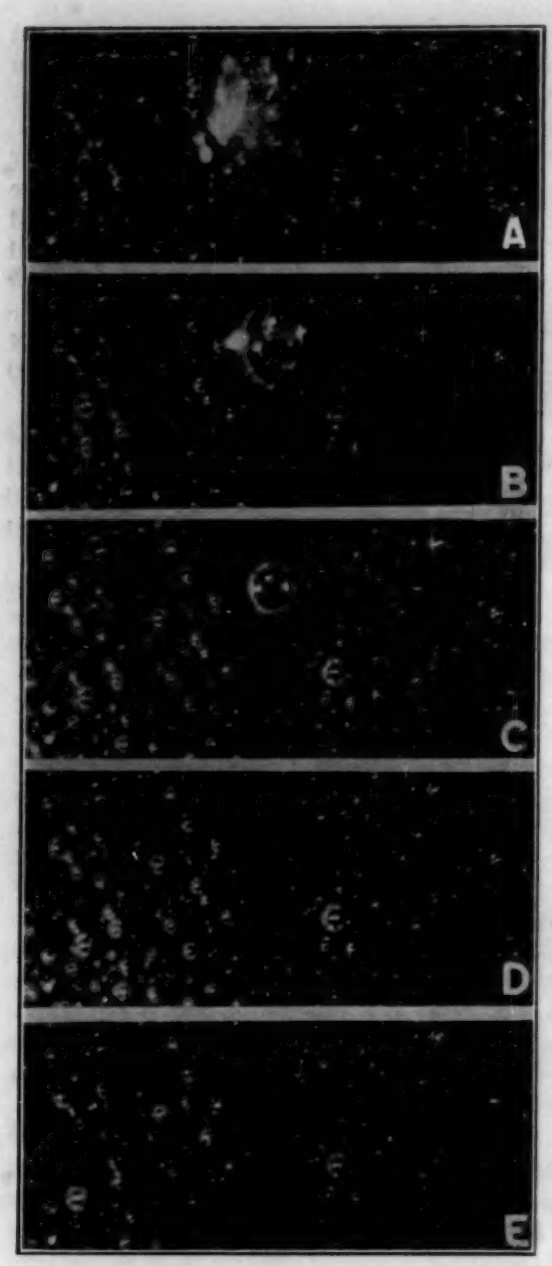

FIG 6.

Figure 4*A* shows the enamel surface prior to the reboil; 4*B*, shortly after the reboil has occurred; 4*C*, at a later time; and 4*D*, after the piece had become badly overfired. There was a small bubble, presumably from a previous firing, at the exact spot where the reboil bubble appeared in 4*B*. By the time the firing was complete, the bubble remaining appeared much the same as the one at the beginning (compare Figs. 4*A* and 4*D*).

Figure 5 shows stages in the initial firing of a piece. In 5*A* the bisque coat is showing cracks as the temperature rises; in 5*B* large bubbles are located in the same positions as the cracks; 5*C*, taken after the large bubbles collapsed, shows dark spots where the bubbles had been. The piece was cooled by dropping the bottom of the furnace but not removing the piece from the supports. About 24 hours later the piece was again raised into the heated furnace without having changed its relative position. No reboiling occurred, and the appearance of the surface shows no correlation with that of the partly fired bisque.

Figure 6 is a splendid example of the progress of reboiling. The bulge appears in 6*A*, and 6*B* and 6*C* show the bubble diminishing in size. In 6*D* it has broken, and 6*D* and 6*E* show the discoloration where the bubble was located.

Figure 7 shows a piece that reboiled with numerous bubbles. A number of these can be traced through the various stages of development; 7*A* was taken at the height of the reboil; 7*B* at the conclusion of the reboil; 7*C* and 7*D* show bubbles diminishing in size; 7*D*, taken about 30 seconds after 7*C*, shows the bubbles much reduced in size; 7*E* was taken 30 seconds after 7*D*. The specimen was then removed from the furnace and

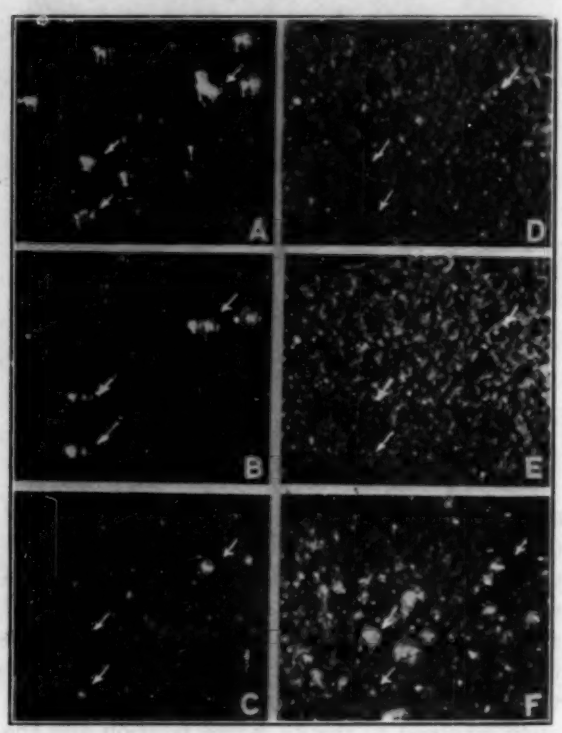

FIG. 7.

cooled. When cold it was returned to the furnace in the same position as before. It reboiled, and some of the reboil bubbles will be found in the same positions as in 7*A*. Some bubbles appear where none was noticed in 7*A* and some of those in 7*A* did not repeat in 7*F*. Where they did repeat, however, there is no doubt about the location.

NOTE: A convenient way of superimposing these pictures to see if they match is by means of a stereoscope. It will be found that all the pictures of Fig. 7 cover exactly the same area.

V. Discussion of Observations and Photomicrographs

The significant facts that are gleaned from the work at hand are as follows:

(1) Reboil bubbles start deep down in the enamel, possibly at the enamel-metal interface or in the metal itself. This is evidenced by the manner in which the surface wrinkles just before reboiling and the bulging of the enamel just before the reboil bubble appears.

(2) Whatever gas is responsible for the reboil bubbles is at least partially absorbed again as the enamel becomes more heated. As the bubble shrinks, the film of enamel above it may become thinner until the bubble finally bursts.

Other interpretations that suggest themselves are as follows: (*a*) The enamel formed a lens over the bubble which was eliminated as the bubble rose. Since, however, the bubble itself is the cause of the bulge, the enamel is thinner above the center of the bulge than elsewhere. This would give a concave lens effect which would work opposite to the manner observed, *i.e.*, the bubble would seem smaller at first and become larger as it rose. (*b*) A second idea was that the bubbles started as flattened layers of gas which gradually became more spherical. This is undoubtedly true but, even so, a study of Figs. 2, 6, and 7 leaves no doubt that the actual volume of the bubble diminishes.

(3) Many of the reboil bubbles do not break at all, but shrink to about the same average size as the rest of the enamel bubbles and show no further change.

(4) Reboil bubbles often appear in the same spot repeatedly in successive firings (see Figs. 4 and 7).

(5) Shrinkage cracks in the partly fired bisque coat are observed to give way to large bubbles in the first firing. In the particular case illustrated, no correlation was found between these and the location of the reboil bubbles (see Fig. 5).

VII. Conclusions

Studies on the subject of reboiling in the past few years have brought forth a great many conflicting data. The present studies were made in an effort to clear up and correlate some of this conflicting information rather than to increase its volume. The principal point brought out is the shrinking of the reboil bubbles, which should help materially in answering some of the baffling questions regarding reboiling.

Previous work has shown that most ground coats reboil on some steels but not on others, that some ground coats are less likely to reboil than others, and that surface conditions as well as manner of application seem at times to affect the ware. Lucian and Kautz[3] concluded that the gases causing reboiling come from the enameling iron. Kautz[4] has suggested that CO caused by the oxidation of the carbon in the enameling iron is responsible for the reboil bubbles.

One of the most difficult things to explain has been the fact that a piece will reboil again and again on repeated firings, but during any one firing the reboiling activity subsides after the piece has been heated for some time and will not occur until the piece is cooled and refired. No simple evolution of gas from either enamel or metal can satisfactorily explain this. The shrinkage of the bubbles after forming suggests the possibility of a chemical mechanism for completing the reboiling cycle. In our opinion the carbon-oxide principle suggested by Kautz fits such a mechanism.

Thus the formation of CO by oxidation of the metal may supply the gas for the reboil bubbles. It will be limited, however, by the amount of oxygen available at any time for oxidizing the metal. The bubble, having formed, may burst or may be reabsorbed at a higher temperature. A complete explanation of how the CO gas may be absorbed will require further investigation. It seems highly possible, however, that this can happen.

Data have been published recently relating to the equilibrium relations between iron and its various oxides. The equilibrium diagram of

[3] A. N. Lucian and Karl Kautz, "A Further Progress Report on the Study of Gases in Enameling Iron," *Jour. Amer. Ceram. Soc.*, 17 [6] 167–72 (1934).

[4] Karl Kautz, "The Source of Reboiling Gases in Porcelain Enameled Iron," *Enamelist*, 13 [6] 10–13 (1936).

Mathewson, Spire, and Milligan[5] indicates a considerable solid solubility range around the composition FeO above 570°C. This narrows down to a eutectoid point at 570°C; below this temperature, only Fe_3O_4 and iron can exist in equilibrium, ferrous oxide being unstable.

If a bubble of CO gas is in contact with ferrous oxide at a temperature above 570°C and the ferrous oxide is at its maximum iron concentration (as it would be if in contact with metallic iron), it might easily have sufficient reducing power to reduce the CO to carbon, which would dissolve in the iron. Upon cooling, the ferrous oxide decomposes by eutectoid dissociation into Fe_3O_4 and iron. The Fe_3O_4 should normally be oxidizing toward carbon. This might result in an incipient formation of CO to be released when the temperature rises again. Diffusion in the solid state might be expected to increase this tendency so that the next time the piece is heated there would be a sudden evolution of bubbles at the time the enamel becomes plastic. As soon as the temperature exceeds 570°C, however, ferrous oxide begins to form and again takes the oxygen, sending the carbon back to the iron.

It must be admitted that this is a fanciful picture. The presence of metallic oxides in the ground coat would have effects which are as yet unknown. The picture is offered only as an indication that, theoretically, a mechanism for the absorption of the bubbles is possible.

[5] C. H. Mathewson, E. Spire, and W. E. Milligan, "Evolution of the Iron Oxygen Constitutional Diagrams," *Trans. Amer. Soc. Steel Treating*, 19 [1] 66–87 (Nov., 1931).

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THE MODULUS OF ELASTICITY OF GLASS*: I

Preliminary Studies: (a) Effect of Thermal History; (b) Effect of Temperature Change

By Guy E. Stong

Abstract

An apparatus has been set up with which the modulus of elasticity of glass may be determined with a probable error of ±0.2%. Results are presented showing that the modulus of this glass varies over a range of 7%, depending upon its previous thermal history, the modulus being higher for low-temperature heat treatments. Determinations of the modulus have been made up to 450°C upon samples having different thermal histories. It has been found that the modulus decreases regularly, the rate of change increasing with rising temperature.

I. Introduction

Investigations of the modulus of elasticity of annealed glass, its variation with chemical composition, and its variation with temperature change were first made by Winkelmann and Schott[1] and by Winkelmann.[2] Recent work on the effect of temperature change has been done,[3] chiefly on fused quartz. Guye and Vassileff[4] and Badger and Silverman[5] have reported work on ordinary soft glass showing abnormal effects at 250° to 300°C. To the writer's knowledge, no work has been reported on the effect of thermal history upon the modulus of elasticity of glass. Littleton,[6] Lillie,[7] Guyer,[8] Tilton, Finn, and Tool,[9]

*Presented at the Annual Meeting, American Ceramic Society, Columbus, Ohio, March 31, 1936 (Glass Division). Received June 24, 1936.

[1] Summarized in Jena Glass and Its Scientific and Industrial Applications, by Hovestadt, pp. 155–57 (English translation by Everett and Everett, 1902).

[2] *Loc. cit.*, pp. 157–68.

[3] (*a*) W. Eitel, M. Pirani, and K. Scheel, Glastechnische Tabellen, p. 179. Julius Springer, Berlin, 1932.
(*b*) C. H. Rees, J. P. Andrews, and L. S. Shave, "Variation of Young's Modulus at High Temperature," *Proc. Phys. Soc.* [London], **36**, 405 (1923); see also references cited by A. Winkelmann and O. Schott, *Ann. Physik. Chem.* (N.F.) **51**, 697 (1894).
(*c*) H. D. H. Drane, "Elastic Constants of Fused Quartz. Change of Young's Modulus with Temperature," *Proc. Roy. Soc.* [London], **A122**, 274 (1929).

[4] C. E. Guye and S. Vassileff, "Interior Friction of Glass as a Function of Temperature," *Arch. sci. phys. nat.*, **4** [37] 214 (1914).

[5] A. E. Badger and W. B. Silverman, "Modulus of Elasticity of Glass in Relation to Temperature," *Jour. Amer. Ceram. Soc.*, **18** [9] 276–80 (1935).

[6] J. T. Littleton, "Critical Temperatures in Silicate Glasses," *Ind. Eng. Chem.*, **25** [7] 748–55 (1933); *Ceram. Abs.*, **12** [10–11] 360 (1933).

[7] H. R. Lillie, "Viscosity-Time-Temperature Relations in Glass at Annealing Temperatures," *Jour. Amer. Ceram. Soc.*, **16** [12] 619–31 (1933).

[8] E. M. Guyer, "Electrical Behavior of Glass at Room Temperature," *ibid.*, **16** [12] 607–18 (1933).

[9] L. W. Tilton, A. N. Finn, and A. Q. Tool, "Some Ef-

and others have shown that thermal history has a marked effect upon numerous other properties of glass, such as viscosity, electrical resistivity, density, thermal expansion, and refractive index. In the optical glassware field, these refractive-index studies have been particularly valuable as they have provided additional means of controlling the refractive index obtained. The entire mass of work on all of the different properties of glass has furnished valuable data from which a better understanding of the constitution and molecular conditions existing in glass under various temperature conditions may be obtained. It seems probable that the thermal history of a glass sample would also affect the modulus of elasticity, and it was with the purpose of investigating this relationship that the present study was undertaken. As the effect of thermal history was studied, particularly for heat treatments at temperatures near the annealing point, it was interesting to follow the value of the modulus throughout the various temperature changes as a means of explaining the change of modulus from one room temperature value to another. This study of the effect of temperature change also emphasized the influence of thermal history in a certain temperature range.

II. Method

Preliminary work showed that the magnitude of the effect to be studied was only a small fraction of the value of the modulus of elasticity, and it was necessary to set up as accurate and as precise an apparatus as possible so that significant results might be obtained. The accuracy of this determination depends upon the accurate measurement of the deflections produced by a load and of the sample dimensions. In the fiber method, only small deflections can be obtained and exact sample dimensions are difficult to establish. For this reason, a method was chosen which involved the use of a rectangular beam centrally loaded in simple bending moment, the deflection being measured at the center of the span. This method gives large deflections for samples, which are of sufficient size to allow considerable accuracy of measurement. The sample dimensions used were 2.5 by 10 by 120 millimeters, the knife-edge distance being 110 millimeters. An applied load of 1 kilogram produced a deflection of about 0.3 millimeter, the maximum stress being 2.5 kilograms per square millimeter.

fects of Carefully Annealing Optical Glass," *Jour. Amer. Ceram. Soc.*, 11 [5] 292–95 (1928).

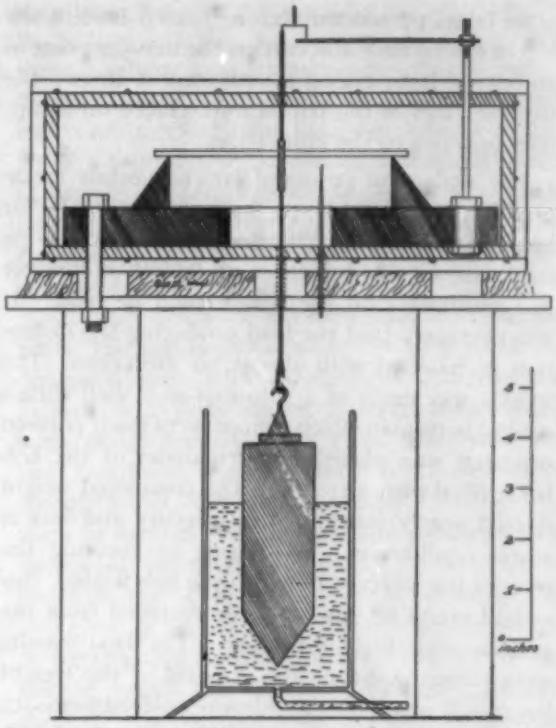

FIG. 1.—Diagram of furnace construction and assembly of apparatus.

III. Apparatus

The knife edges which carried the glass sample were an integral part of a block of stainless steel which was mounted in a specially constructed furnace with removable sides and top. This construction made possible accurate adjustment of the sample before the assembly of the furnace and also permitted measurements to be made with the same equipment at room temperature as for high-temperature work, enabling the room-temperature technique to be applied directly to the high-temperature measurements. The details of the furnace construction are shown in Fig. 1. The furnace core was made of $^1/_4$-inch copper bus bar with sheets of Transite, containing the heating elements, fastened on the outside. After the assembly of the furnace, additional insulation was provided by wrapping glass wool about the apparatus. A thermocouple for temperature readings was placed in free air just below the glass sample. A weight was applied on a $^3/_{32}$-inch rod passing through the bottom of the furnace. A $^1/_{16}$-inch rod, fastened to the top of the loading

knife edge, passed through a $^1/_4$-inch hole in the top of the furnace and carried the moving point of an optical lever tripod constructed of Invar; the two rear legs of the tripod were placed on a support fastened to the knife edges.

The deflection produced was accurately measured by the optical lever, the magnification factor being about 1000. With the scale and telescope used, an actual deflection of 0.0001 millimeter (0.1 millimeter on the scale) could be read. It was necessary that the load producing the deflection be handled with almost no vibration. The weight was made of a thin cast-iron shell with a conical bottom in which a quantity of finely crushed tungsten was placed, the remainder of the bob being filled with mercury. The completed weight floated nearly submerged in mercury and was in stable equilibrium. By raising or lowering the level of the mercury in which the bob floated, this weight could be applied to or removed from the sample with little vibration. The best results were obtained during the removal of the weight because it was difficult to insure perfectly smooth lowering of the bob. Readings were made with the bob completely suspended on the center knife edge and completely removed from the center knife edge, the process of removal being watched in the telescope of the optical lever system to insure that smooth movement of the system was obtained.

IV. Accuracy and Precision of Apparatus

The optical lever was carefully calibrated by measuring the various lengths and angles involved. In this calibration, the probable error of each measurement did not exceed 0.02%. The knife-edge distance was measured to an accuracy of 0.01%. The weight was measured to better than 0.01%, it being found possible to prevent mercury from adhering to the weight by covering the mercury surface with xylene. As the scale could be read to 0.1 millimeter in a total deflection of 300 millimeters, the accuracy of reading was 0.05%. Individual measurements on the same sample frequently checked to the limit of reading. In general, the probable error of a group of measurements on an individual sample was found to be 0.05%. Thus the greatest source of error in the determinations was the measurement of the sample thickness. It was found possible to measure the thickness of the sample to 0.002 millimeter or better with a micrometer, which was found to be correct to about 0.001 millimeter at the two positions used by checking against gage blocks; the probable error of the determination of sample dimensions was therefore about 0.2% in the cube of the thickness.

V. Computations

In the computations of this work, the angle through which the mirror moved was obtained by means of the tangent relationship, the distance between mirror and scale, the scale length, and the scale reading for which the mirror was vertical being known. As a result of the construction of the tripod, the deflection was computed from this angle by the relationship,

$$\text{Deflection} = A\,(\sin[\alpha + \psi] - \sin\psi).$$

Where α = angle through which mirror moved.
A = perpendicular distance from moving point to line joining 2 pivot points of the optical lever tripod.
ψ = angle between plane of points of tripod and horizontal.

This derivation is shown in Fig. 2.

Young's modulus was then computed from the deflection by the formula,

$$E = \frac{Wl^3}{4\,Xbd^3}.$$

Where W = applied load.
l = knife-edge span.
X = deflection.
b = width of sample.
d = thickness of sample.

To this a correction of 0.18% was necessary for this size sample for deflection due to shear, the correction being added to the value of the modulus of elasticity as computed above.

For the measurements made at elevated temperatures, it was necessary to correct for the expansions of the sample and of the knife edges. The expansion coefficients for both the glass and

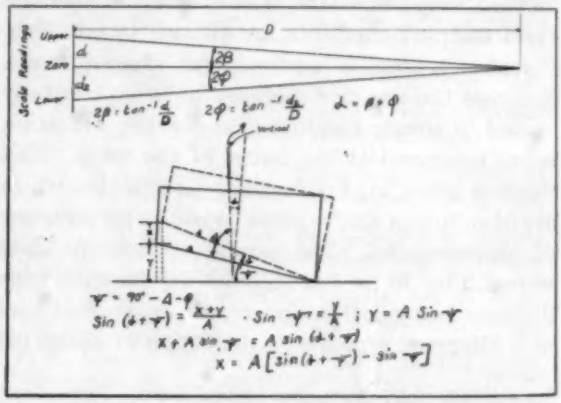

FIG. 2.—Derivation of formulas.

the knife-edge metal were measured at intervals throughout the temperature range used so that this correction could be made accurately. At temperatures above 350°C, viscous flow was found to occur in the sample when the load was applied. A correction was made for this flow by observing the sample under load for a definite period of time. The deflection for this time furnished data from which a correction could be applied to the deflection produced when the weight was completely removed, the time required for removal being measured.

At temperatures above 350°C, the accuracy with which the scale could be read was decreased, owing to the fact that some flow of hot air occurred in front of the optical tripod mirror. This, in conjunction with the corrections necessary for viscous flow, rendered the measurements made at above 350°C somewhat less accurate, but it is estimated that individual readings were good to 0.5% and the probable error for the number of readings taken was about 0.2%.

VI. Preparation of Samples

The samples used in this work were taken from six $6^1/_2$-inch squares from the same melt of Corning bulb glass No. 8. The softening point of this glass is 695°C, the annealing point 510°C, and the strain point 480°C. Twenty-four samples were first ground and polished to 3.0 by 12 by 140 millimeters. Two of these samples (A and K) were preheated for 5 minutes at 450°C, placed on a plate at 850°C, and heated in a furnace at 850°C for 1 minute (beyond this time serious distortion occurred). The samples were chilled, the resulting strain in the center showing a value of 200 mμ per centimeter tension.

Two other samples (C and D), after preheating as above, were placed on a plate at 800°C, heated for 2 minutes in a furnace at 800°C, and chilled. In the same way, two samples (E and F) were chilled from 750°C after 3 minutes' heating, and two (L and M) from 700°C after heating for 4 minutes. Two samples (I and J), heated at 575° C for 5 minutes, were allowed to cool in air. These samples were ground and polished for modulus determinations to 2.5 by 10 by 120 millimeters, as stated above.

VII. Experimental Work

The two effects studied were those of (1) the thermal history described in Section VII(A) and (2) the variation of modulus with temperature described in Section VII(B). In Section (A) the glass is given a definite heat treatment and the modulus is determined on the cold sample. These measurements are referred to as determinations Nos. 1 to 19. In Section (B), the measurements were made at various temperatures as the temperature of the sample was increased from and decreased to room temperature. These series of measurements are referred to as runs Nos. 1 to 4.

Although the work has been separated into two parts, the experimental work for both parts was done as a unit. All the measurements of modulus in Section (A) were made at room temperature; some of the samples were given more than one heat treatment, a measurement being made upon completion of each heat treatment. Because the work in Section (B) amounted to a definite heat treatment, the room-temperature values of modulus at the end of the runs to high temperatures are also given in Section (A). The modulus of sample A, for example, was first measured on the chilled sample, which was then put through high-temperature run No. 1. After this run, the sample was heat-treated and cooled at $^1/_2$°C per minute. After measuring the room-temperature modulus, the sample was put through run No. 2.

(A) Effect of Thermal History

Measurements of the modulus of elasticity of the ten samples chilled as described above were made, together with measurements of a sample B from the original commercially annealed glass and are given in determinations Nos. 1 to 11 (Table I). Sample A was subjected to run No. 1, and the room-temperature value (16) of its modulus was measured after this run. Measurements on Samples A and B were then made after an annealing heat treatment, held at the annealing point for 15 minutes, and cooled for 200°C at the rate of $^1/_2$°C per minute (determinations Nos. 14 and 15). Samples C and D were annealed similarly but cooled at the rate of 1°C per minute and their moduli measured (determinations Nos. 12 and 13). After run No. 2 on sample A, the room-temperature modulus (determination No. 17) was measured; similarly determination No. 18 after run No. 3 on sample K and determination No. 19 after run No. 4 on sample D were measured.

From these results, it is evident that the modulus of this glass is considerably affected by previous thermal history, being increased as the tem-

perature of heat treatment is lowered. The modulus is also affected by the rate of cooling from the annealing point, as is shown by determinations Nos. 11, 12, 13, 14, and 15, being increased as the cooling rate is decreased. Thus it is not sufficient to specify "annealed glass" when reporting values of modulus of high accuracy. The complete annealing schedule must be given.

The changes in modulus are reversible, as shown by the agreements in determinations Nos. 16 and 17 on sample A, although the sample was in the chilled state (determination No. 1) at the beginning of run No. 1 and had been annealed at ½°C per minute (determination No. 14) between the first and second runs, this treatment giving a value lower than these end values. The agreement between these values (Nos. 16 and 17) also shows the high precision which may be obtained by the apparatus, the two values checking to ±0.002%.

Considering the values of modulus for samples L and M (determinations Nos. 7 and 8), for samples I and J (determinations Nos. 9 and 10), and for sample B (determination No. 11), it is evident that the modulus of this glass is lowered as the glass is heated to temperatures above the annealing point and quickly cooled. From a consideration of the method of sample preparation and of the values of modulus for those samples heated at temperatures above 700°C (determinations Nos. 1 to 6), it is believed that the samples probably did not reach 700°C and certainly not the temperature of the heating furnace. As the temperature of the furnace was raised, the heating time was decreased, becoming more critical, so that the opportunity for discrepancy in the heat treatment received by two samples would increase. Such a discrepancy in heat treatment probably explains the difference in the value of modulus for samples A and K (determinations Nos. 1 and 2), indicating that sample A received a few seconds' less heating than sample K.

It thus appears that the method used here for sample preparation is satisfactory for heating temperatures up to the softening point of the glass but that for an investigation of the modulus of samples chilled from higher temperatures some other method is necessary. A more comprehensive study of the variation of modulus with heating temperature for the range between the annealing and softening points would probably be of considerable interest.

(B) Effect of Temperature Change

A high-temperature run was made on sample A after determination No. 1, the sample showing about 200 mμ per centimeter birefringence in tension at the beginning of the run. This run was made on a heating schedule of 3 hours per 50°C temperature interval; the furnace was allowed to come to constant temperature and measurements were made about two hours after each temperature increase. This time-temperature schedule was followed throughout the run with the exception that the furnace was at 450°C for 5 hours before measurements were made. After making the determination at 450°C, the furnace was cooled (50°C for each 3-hour interval), and measurements of modulus were made at the several temperatures during cooling. After removal from the furnace, the sample was found to be almost completely strain-free and to have an increased density, the sample dimensions having decreased by about 0.1%. In computing the results, the room-temperature dimensions of the chilled sample were used on the upward curve, and the room-temperature dimensions of the sample after removal from the furnace were used for the down-

TABLE I

EFFECT OF THERMAL HISTORY ON MODULUS OF ELASTICITY

Heat treatment	Sample	Determination No.	Modulus (kg./mm.²)	Heat treatment	Sample	Determination No.	Modulus (kg./mm.²)
Heated at 850°C	A	1	7296	Commercial annealing	B	11	7453
	K	2	7153	Annealed at 1°C/min.	C	12	7506
Heated at 800°C	C	3	7211		D	13	7505
	D	4	7212	Annealed at ½°C/min.	A	14	7545
Heated at 750°C	E	5	7199		B	15	7515
	F	6	7175	Held at 450°C for 5 hr. or more	A (after run No. 1)	16	7611
Heated at 700°C	L	7	7132		A (after run No. 2)	17	7612
	M	8	7168		K (after run No. 3)	18	7612
Heated at 575°C	I	9	7264		D (after run No. 4)	19	7623
	J	10	7256				

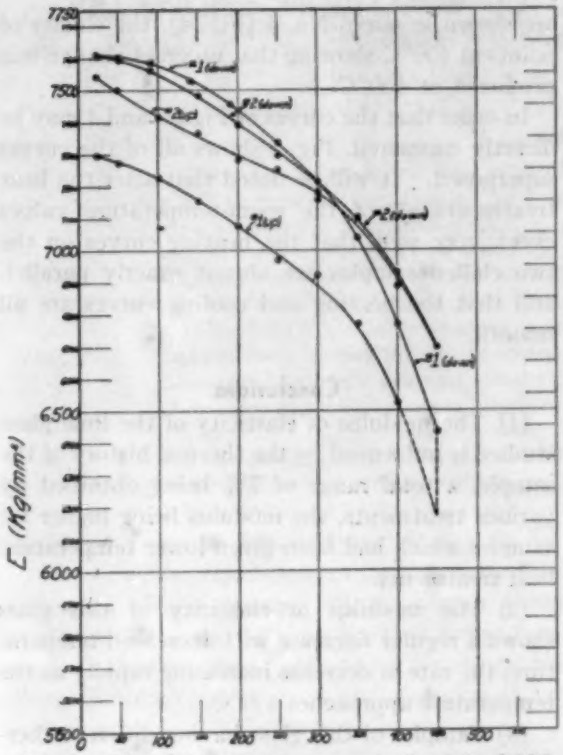

FIG. 3.—Modulus-temperature curves for 3 hr./50°C schedule.

ward curve. The results of this run are shown in curve No. 1, Fig. 3. It will be noted that a marked change in the modulus of elasticity of this sample occurred as a result of the heat treatment received.

To investigate the heat treatment effect found above, the sample was annealed at ½°C per minute as explained in Section (A). This annealed sample, after measurements at room temperature (determination No. 14), was placed in the furnace and subjected to a second run to 450°C, the time-temperature schedule being maintained, as nearly as possible, identical with the first run. The results of this work are shown on curve No. 2, Fig. 3. The downward curve for the chilled samples (No. 1 down) is shown to be considerably above the upward curve for the annealed sample (No. 2 up), while the lower temperature portions of the downward curves for the two runs (Nos. 1 and 2 down) are nearly the same, although the value of modulus at 450°C for the annealed sample is much higher than for the chilled sample. This suggests that the chilled sample did not reach equilibrium while being held at 450°C, although it was considerably affected by this heat treatment.

Since the heat treatment at 450°C affects a sample in the time given on the above heating schedule, an investigation was made of the modulus-temperature curve for samples heated as rapidly as possible, measurements being taken during the run while the temperature increased. These measurements would be less accurate than those shown above because only one measurement could be obtained at any temperature and because some doubt exists as to the actual temperature of the glass.

The second sample, K, chilled from 850°C was, therefore, subjected to a high-temperature run, No. 3, measurements of modulus being made as frequently as possible during the heating period. The time-temperature curve for this run averaged 100° per hour, the temperature rising more slowly when the furnace reached 350°C. After measuring the modulus immediately upon reaching 450°C, the furnace was maintained at this temperature while other measurements were made after ½ hour, 1½ hours, 14½ hours, and 39 hours. The furnace was allowed to cool at about 100°C per hour, and measurements of modulus were made as frequently as possible during cooling.

The room-temperature dimensions of this

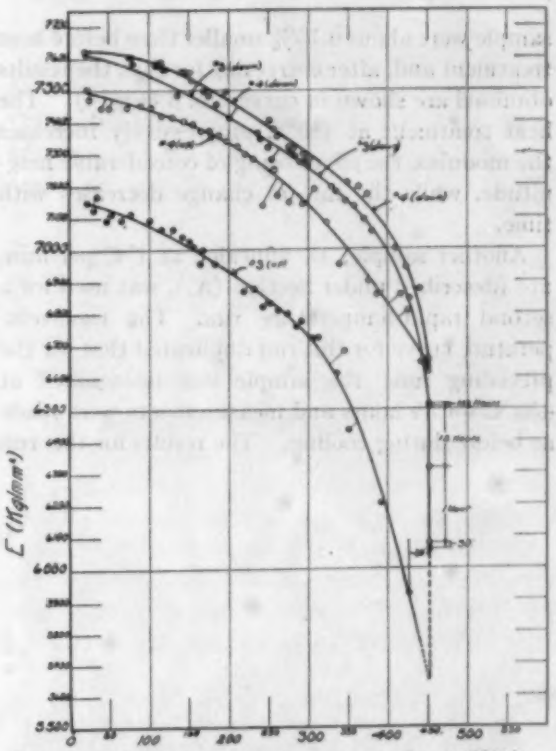

FIG. 4.—Modulus-temperature curves for 100°C/hr. schedule.

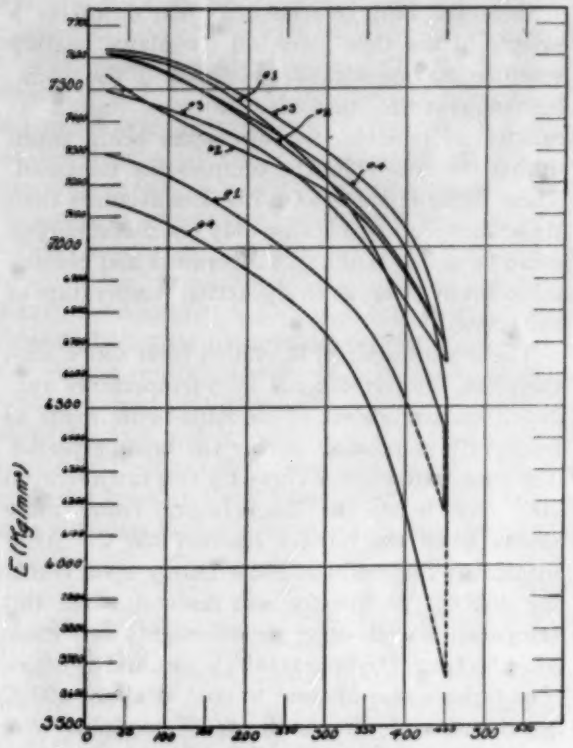

FIG. 5.—Composite of Figs. 3 and 4.

sample were about 0.15% smaller than before heat treatment and, after correcting for this, the results obtained are shown in curve No. 3 (Fig. 4). The heat treatment at 450°C progressively increases the modulus, the effect being of considerable magnitude, while the rate of change decreases with time.

Another sample, D, annealed at 1°C per minute (described under Section (A)), was used for a second rapid-temperature run. The time-temperature curve for this run duplicated that for the preceding run; the sample was maintained at 450°C for 39 hours and measurements were made as before during cooling. The results for this run are shown in curve No. 4 (Fig. 4), the cluster of points at 450°C showing that no great change was produced at 450°C.

In order that the curves of Figs. 3 and 4 may be directly compared, Fig. 5 shows all of the curves superposed. It will be noted that after the heat treatments all of the room-temperature values check very well, that the heating curves on the two chilled samples are almost exactly parallel, and that the heating and cooling curves are all smooth.

Conclusions

(1) The modulus of elasticity of the lime glass studied is influenced by the thermal history of the sample, a total range of 7% being obtained by various treatments, the modulus being higher for samples which had been given lower temperature heat treatments.

(2) The modulus of elasticity of this glass shows a regular decrease with increased temperature, the rate of decrease increasing rapidly as the temperature approaches 450°C.

(3) Samples of this glass having different thermal histories show decidedly different modulus temperature curves.

(4) The modulus of elasticity of this glass depends upon the thermal history of the sample and it is possible to determine the relation between modulus and heat treatment up to the softening point. If this were done, it would be possible, by measuring the modulus of a sample having an unknown or indeterminate heat treatment, to state definitely the equilibrium condition corresponding to that set in the glass by the heat treatment to which it had been subjected.

Acknowledgment

The author wishes to express his appreciation of the advice of H. R. Lillie of this Laboratory.

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CORNING GLASS WORKS
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BALANCING HOLLOW-WARE DIES WITHOUT THE USE OF DRAGS THEREBY INCREASING CAPACITY*

By H. L. Longenecker

Abstract

To produce ware which will not crack in the drier, tile must be extruded from a die at a uniform velocity across the die. It is sometimes difficult to make the clay fill the corners of a large die. In common practice, a die is balanced by placing drags on the rear ends of the core post at the section of the die which runs fast, retarding the clay flow at that point sufficiently to equalize the flow across the die. The difficulty in filling the corners is overcome by making deep semicircular gouges in the die behind the corners.

It has been found better practice to speed the slow parts of the die by altering the taper of cores, shifting the cores sidewise to increase the web thickness at the slow sections, and thinning the web thickness at the fast sections. Gouging the corners is a form of dragging which is overcome by using better design.

Experimental data, drawings, photographs, instructions for die building and balancing, and proper taper of dies and cores are given. A die balanced without drags increases the tonnage per hour and reduces the power requirements.

I. Introduction

When clay is extruded from an auger machine through a tile die the clay column travels faster at the center of the die, because that is the focal point of the compressive extruding forces and because frictional resistance of the die parts is less at that point.

Hence, in an unbalanced hollow-ware die, the clay column splits almost centrally, refusing to form the desired tile column. The three solutions of this problem are based on two opposed lines of thought.

The first solution is to manually oppose the tile column to make effective the mass cohesive power of the clay. This method makes no effort to balance the die to equalize pressure forces and prevent the resultant internal strains. Some clays are sufficiently tough and cohesive that these strains adjust themselves in the smaller sizes of tile, permitting the drying to take place without cracking. With larger size tile, this method fails and it is necessary to balance the rates of clay flow across the face of the die. Two ways of balancing the clay flow are (1) to retard the flow of clay at the center of the die to equal the flow of the slower outer parts of the die by interposing resistance at the fast sections, and (2) to speed the flow at the slower parts of the die to equal the flow at the fast central part by reducing resistance at the slow outer section.

II. Use of Retarders or Drags

It has been the practice for many years to use these retarders, baffles, or drags, behind the fast parts of the die to slow the column center. These drags are of many patterns and sizes: five-, six-, and eight-pointed stars, figure eights, squares, rectangles and diamond shapes, and composites. Some of these drags are of as great an area as the core behind which they are placed. All are fastened to the core bridges as far behind the die as possible, and they are generally secured under the core post nut.

Another common method is the use of a "gouge," a three-quarter circular tapered opening behind the die corners (Fig. 1). The idea is to open the throat of the die at these points and induce a stronger flow of clay to the corners. As clay under pressure may be considered a viscous fluid and therefore subject to the laws which govern fluids, this idea is basically wrong.[1] The coefficient of friction of clay upon clay is supposed to be less than that of clay upon metal. By thus extending the area of metal against which the clay must move, the power required is increased.

III. Balancing a Die without the Use of Drags

The die casting should be at least two inches thick for strength. Internal scorers are preferable to external scorers, as they have less tendency to ruffle the column. The simplest holder for internal scoring plates is a light casting secured to the die casting by stud bolts. This casting is $1\frac{1}{4}$ inches thick and is mounted on a $\frac{1}{4}$-

* Presented at the Annual Meeting, American Ceramic Society, Columbus, Ohio, March 31, 1936 (Structural Clay Products Division). Received March 23, 1936.

[1] Editorial Note: This does not always hold, but is a factor up to the point of the breaking through of a "slip plane." The author's statement does not agree with those of Ellis Lovejoy and H. B. Henderson: see "Stiff-Mud Die Troubles," *Jour. Amer. Ceram. Soc.*, 13 [11] 787–93 (1930).

inch boss. The die thus becomes $3^1/_2$ inches thick.

Cores that are too long consume too much power; if they are too short, they will not core the tile properly. Cores $2^1/_2$ inches long have been adopted by this plant as standard. The hole in the core is drilled large to permit shifting the core on its post. A washer $^1/_4$ inch thick is used under the tightening nut as a thinner washer will cup under pressure.

When a new die is received, it should be checked carefully. The die opening should center on the auger. The other cores should all be set in relation to the center core.

After the die is properly centered on the machine, run out a short column. Break the column flush with the face of the die, and run out a six- or eight-inch column. This must be done quickly

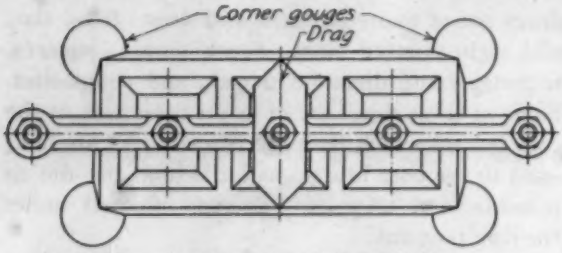

FIG. 1.—Rear view of dragged die.

to avoid loss of oil. Then with a straight edge determine which part of the die is fast.

When specifications of thickness of webb and shell do not have to be met, or where the change will not cause thickness differences beyond the allowed variation, balance may be secured by shifting the cores on their posts. Shift the cores so that the webb will be thinner at the fast part of the die and thicker at the slow part to increase the general speed of the die. All adjustments are made without removing the die from the machine.

NOTE: By careful study of dies after they have been broken in and have attained maximum speed, the proper taper of the die casting has been found to be 12 degrees for clay used by the Cherokee Brick Company. All changing to balance dies is done with the cores.

Practically 90% of drier cracking in tile can be traced back to die balance. In many plants, die balance is determined after a trial car of tile from a new die has been dried. At the Cherokee Brick Company, there has been developed a method whereby without drying the tile, they determine whether the die is in balance so the tile will come through without cracking.

The machine is started with the new die in place and a short section of column run out. If the die is fast in the center, the center of the tile column will issue faster and the tile section will be convex (see Fig. 2A at the junction of the center webbs). With shifting of cores or other balancing, the tile column will issue so that the broken section is straight across, neither convex nor concave. When the flow is balanced so the broken section will be concave (or as we say, will "cup"), we know that the tile will dry safely. This "cup" must be from $^1/_2$ to $^3/_4$ inch in depth. So important is this matter of cup that, on a new die, a daily record is kept of its depth and is compared with drier loss per car average. This cup will show on both ends of the tile. Such tile dry and fire perfectly and come out of the kilns perfectly square.

The proper amount of cup varies with the size of the tile from $^1/_2$ inch as a minimum to 1 inch maximum but seems to be about $^1/_{16}$ inch for each 1-inch width of tile. Thus a 12-inch tile, 8 by 12, or 12 by 12, will have a $^3/_4$-inch cup.

IV. Balancing without Increasing or Decreasing Shell and Webb Thickness

Core shifting has its limits in all cases and, when meeting exact dimension specifications, these limits are sometimes too narrow to permit die balancing by this method alone. By increasing the taper of the cores the slow webbs will be speeded. Eighteen degrees of taper has been found to be the maximum allowable. Increasing core taper beyond 18 degrees will reduce the speed of clay flow.

The cores as used at the Cherokee Brick Company are uniformly $2^1/_2$ inches long. Originally the cores were faced with a piece of hardened steel $^1/_2$ inch thick. This had straight sides. The cast-iron part of the core behind it carried all of the taper. As used today, the entire core is of cast iron but made in the same way. The first one-half inch of core depth is made with straight sides and the taper is all on the 2-inch section. In this two-inch length, one degree of arc can be figured as $^1/_{32}$ inch.

V. Summary

While it is possible to balance a die by the use of drags, additional power must be supplied to

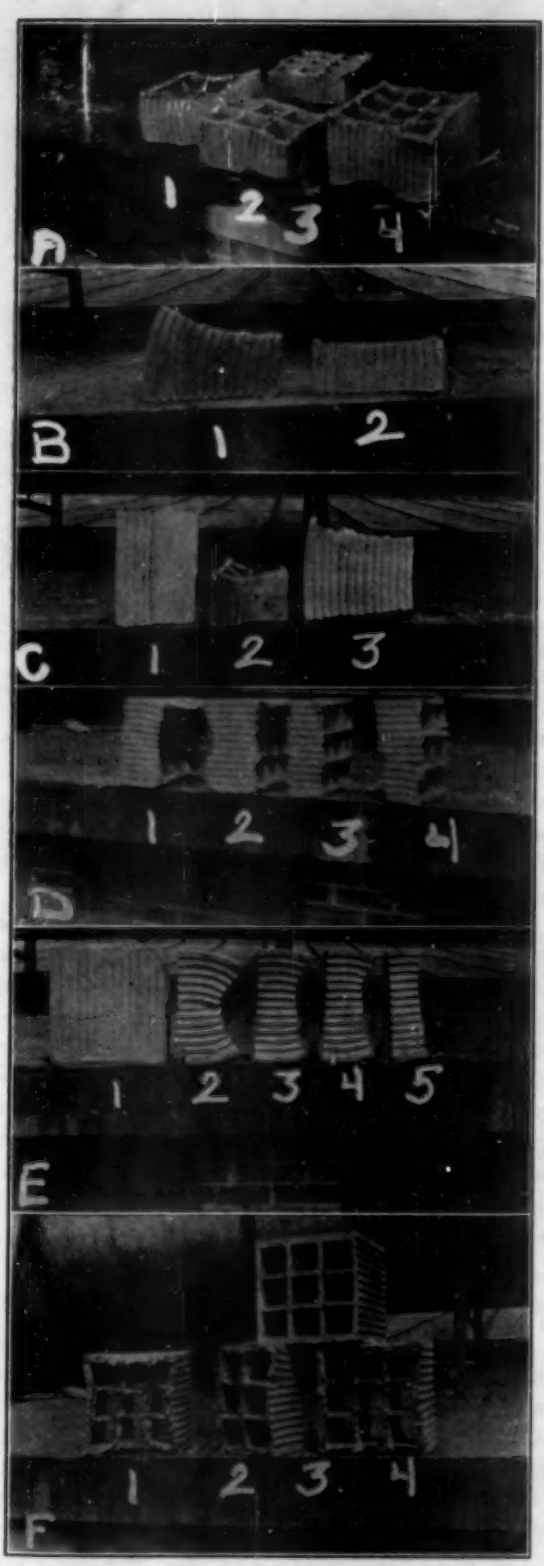

FIG. 2.—For an explanation of this photograph, see the Supplement.

overcome the resistance interposed by the drags.

It is possible to balance some dies by shifting cores. Where the tile is supplied to meet exact specifications, the webb and shell thickness of some tile so balanced will be unsatisfactory.

The best way to balance dies is by changing the angle or taper of the cores to increase the flow of clay at the slow part of the die. Balancing in this manner increases the rate of flow of clay from the die without increase of power.

Testing the undried tile for balance, by determining whether the tile column is fast or slow at the center by the amount of concave or "cup" of a trial section, saves the time required to dry a tile specimen.

Supplement

The photographs shown in Fig. 2, taken of tile and tile column sections, illustrate some of the experimenting necessary to balance a die in the manner outlined in this paper. Samples A, D, and F show different views of the same tile and tile sections.

Sample A-1 is a section of a tile column retarded too much in the center. This tile section has too much "cup." The outside of the tile when dried would tend toward an oval; other views of this tile are shown in samples D-1 and F-1.

Samples A-2, D-3, and F-2 show a tile section too fast in the center; in drying, this tile cracked at the intersection of the center webbs.

Samples A-3, D-3, and F-3 show an attempt to balance this die by shifting cores. The tile section was almost straight, without any cup, but it was too fast in the center. This die was run two days, 120 cars of 33 tile each per day. The drier loss on the run for the first day was 26.5% and on the second day 20%. F-3 shows webb cracks at intersections.

The die was then balanced by changing the taper of the cores. Samples A-4, D-2, and F-4 show a section made from this correctly balanced die. The tile section has a cup of $1^1/_4$ inches. The die was run two days and the drier loss was less than 1%.

Sample B-1 is a section of a 4- by 12-tile column in which the left side was too fast because the shell was $^1/_{32}$ inch thicker than the right side.

Sample B-2 is a tile section from the same die after the cores had been shifted $^1/_{32}$ inch to the right. A good run of tile was made from the corrected die and the drier loss was less than 1%.

Sample C-1 is a T tile warped and too fast on the bottom.

Sample C-2 is a machine section of the sample C-1; the center is slow and the bottom fast; to correct this the two bottom cores were slipped down on the core posts making the bottom shell $^1/_{64}$ inch thinner. The tile was then run without loss.

Sample C-3 is a section of 4 by 12 tile too fast on the left side; same condition as B-1.

Sample E-1 is a 4 by 12 tile made from the same column from which machine section E-2 was taken. The tile was

warped on the top and bottom of the shell, cross-cracked, curved on the end; an unsalable tile.

Sample E-5 shows the first step in balancing; the tile has insufficient cup, is too fast in the center, and will break in the drier.

Samples E-3 and E-4 are sections of the tile correctly balanced, $1^1/_4$ inch cup; the die ran without loss.

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PRESENT PRACTICE AND DEVELOPMENTS IN THE FIRING OF ELECTRICAL PORCELAIN*

By E. H. Fritz

In firing electrical porcelain at the present time, defect scaused by under- and overfiring have been eliminated. The quality of the product has also been improved in other respects. Firing and cooling cycles have been decreased to 72 hours with tremendous economic advantages and maintenance of high-quality ware standards. This cycle is used for the complete line of designs being manufactured.

I. Introduction

Firing treatment of electrical porcelain is important because the ability of electrical porcelain to insulate electrically is dependent upon its proper vitrification. Therefore, to obtain uniform heat distribution in the kilns was one of the first problems, and with the periodic kilns of the early days, the solution of this problem was not easy. It was not uncommon in those days to find porous porcelain on a transmission line, and many of the power failures which were so frequent then could be traced to insulators punctured because of porosity.

Either underfiring or overfiring develops a porous structure which, when subjected to outdoor weather conditions on a transmission line, soon results in absorption of moisture with consequent loss of insulating properties. This condition no longer exists today because power failures now are negligible, and the solution of this problem as well as others, both economic and in quality, is evidence of the progress that has been made in the firing of this product.

Note: Assistance in this investigation was obtained from the technical literature and the publications of the American Ceramic Society. The ceramic trade press also contains much valuable data on this subject.

II. Previous Practice

The kilns generally used for electrical porcelain prior to the advent of the tunnel kiln were the updraft direct-fire type. The firing of this kiln was much improved by manipulation of the draft, but it was at best a very wasteful kiln.

The type of fuel used dictated largely the details of the changes made, but in general they involved reproportioning the various flue areas and changing the size of the fire boxes, particularly reducing the depth when natural gas was the fuel. CO_2 determinations indicated 600% excess air throughout most of the firing. High excess air is needed in this type of kiln, particularly through the oxidation stage, but this amount seemed excessive after oxidation was complete.

This condition led to the installation of dampers in the top of the bottle-shaped stack. It was now possible to reduce the draft a great deal after the oxidation period so that the top of the kiln chamber was actually under a slight pressure which is favorable for more uniform heat at the top of the kiln setting where much of the porous porcelain had always been found. These changes were also beneficial from an economic standpoint, because there was an average reduction of 20% in fuel consumption.

III. Other Development Work Aiding Firing Problems

While this work was going on, research was being made on the effect of grain size, particularly of the feldspar, on the firing results. Rieke[1] corroborated the conclusions of previous investigators, finding considerably earlier vitrification of all porcelain compositions when finer grain feldspar was used. Feldspar as it was then pro-

* A thesis presented for the professional degree of Ceramic Engineer, Ohio State University, Columbus, Ohio, 1936. Received July 7, 1936.

[1] R. Rieke, "The Influence of Size of Grain of the Aggregate on the Behavior of Fine Ceramic Masses During Firing," *Sprechsaal* (1917).

duced was very coarsely ground, but in spite of recommendations to the producers, it was not possible to obtain the fineness that seemed necessary. This grain fineness seemed desirable to the electrical porcelain manufacturers to aid in the vitrification of the product and thereby to assist in their effort to eliminate porosity; as a result they installed their own grinding equipment which made them independent of the variable and generally coarse grinding of the producers. The results justified this step. Vitrification proceeded more rapidly, and the firing range of the body was increased which simplified the problem of obtaining complete vitrification throughout the kiln without overfiring parts of it. Finer and more uniformly ground feldspar and flint are now made available by the producers, and while some additional grinding is still done by the manufacturers, the amount has been considerably reduced. The usual residue formerly was 20 to 30% on 325-mesh; at the present time this residue will now run uniformly between 8 and 10% on standard grades.

IV. Effect of Firing Treatment on Physical Properties of Porcelain

With the improvement that had thus been brought about in obtaining complete and more uniform vitrification, the elimination of porosity became possible and overfire rarely occurred. This ended not only the danger of faulty insulators on a transmission line, owing to porosity, but also resulted in improved mechanical and impact strength. It is well established that porcelain reaches its maximum transverse, compressive, and impact strength when the minimum porosity is reached. As the temperature is increased and overfiring is approached but before there is any increase in porosity, these values again begin to recede. Sortwell[2] shows this in his investigation of vitreous china bodies which are comparable to electrical porcelain in this respect. This is also true of dielectric strength as shown by Monack, Shardlow, and Wamsley[3] in more recent work.

V. Effect of Firing Treatment on Thermal-Shock Characteristics of Porcelain

The need for improving the thermal-shock characteristics of the porcelain introduced another firing cycle problem. Because of the demand by the public utilities for more dependable and longer life insulators to improve their own service, thermal-shock tests were placed in their specifications. These tests involved repeated cycles of immersions in water between extremes in temperature as high as boiling and freezing. The severity of this test can be appreciated particularly when it is considered that electrical porcelain designs are comparatively thick and variable in cross-section.

In the course of the tests that were made, it became apparent that there was a difference in the performance between individual kilns, indicating that the firing procedure influenced the ability of the porcelain to pass such tests. A study was made therefore to determine some of the variations in the firing and cooling cycles, the cooling cycle being considered in this case because it was strongly suggested that the quartz inversion at 575° with its volume changes had a considerable effect on this problem. Furthermore, it had been found that the coefficient of expansion of quartz above and below this point is not the same. Kohl[4] points out that the expansion of quartz below 575° is regular and high compared to the other constituents of porcelain. The inversion from alpha to beta quartz involves considerable volume change, and Kohl also shows that in the beta form above 575° there is a slight contraction rather than further expansion. The increased importance of the temperature cycle below 575°, therefore, is apparent.

In the study that was made, the heating-up cycle was not given much attention, inasmuch as the oxidation period and the elimination of mechanical and chemical water through this stage together keep the rate within safe bounds. On the cooling side, however, studies were directed, owing to the effect of weather conditions on the rate of cooling of periodic kilns and the lack of any definite procedure in cooling. Tests that were made on insulators cooled at various rates above and below 575° showed definitely the increased brittleness and resulting inferior thermal-shock performance of the porcelain if the cooling was rapid from 650° down. Above that point the rate had no apparent effect. On the other hand, with slow cooling below that temperature, satis-

[2] H. H. Sortwell, "Effect of Variation in Firing on the Physical Properties of Vitreous China Bodies," *Jour. Amer. Ceram. Soc.*, 6 [8] 915–36 (1923).

[3] A. J. Monack, L. R. Shardlow, and D. H. Wamsley, "The Dielectric Strength of Porcelain—the Influence of Firing Temperature," *ibid.*, 15 [2] 126–29 (1932).

[4] H. Kohl, "Heat Expansion and Some Other Physical Properties of Porcelains as a Function of the Composition and the Firing Temperature," *Ber. deut. keram. Ges.*, 3 [6] 305–44 (1922).

factory thermal-shock properties were obtained. This led to an established cooling cycle, cooling rapidly in the early stages and slowly below 650°C.

VI. Introduction of the Tunnel Kiln

The tunnel kiln came into use at this time. The developments in firing procedure with periodic kilns were readily adapted to the tunnel kiln and to some extent dictated its design and the control features. A description of these developments and the kiln built for this plant was published several years ago.[5]

VII. Problems of Tunnel-Kiln Firing

In the period of high business activity, it was necessary to obtain the maximum output from the tunnel kiln. Maintaining proper oxidation of the porcelain was a major limiting factor. The condition confined itself to the inner parts of the cars at the bottom, which was to be expected, but CO_2 measurements indicated that the kiln atmosphere was sufficiently high in excess air. This suggested that the temperature cycle in this part of the cars was not the most favorable for oxidation.

VIII. Developments and Tests

Research was first conducted in the laboratory on the rate of oxidation of the porcelain body and the individual ball clays. The results of this work[6] showed definitely that oxidation proceeds rapidly, starting at 250°C and continuing up to 650°, and it is dependent almost entirely on temperature, provided a reasonable firing time schedule is followed. These results seemed to make the problem more simple because, if a temperature increase not exceeding 25°C per hour could be maintained through this range over all parts of the car, satisfactory oxidizing conditions should result.

Continuous temperature measurements were taken on a car as it passed through the heating-up cycle by fastening thermocouples on the ware setting and by unwinding the lead wire from a reel as the car moved. Couples were fastened at four points: the top, bottom, outside, and inside, respectively. At the same time, to get a more definite measurement of blue core conditions, porcelain rods, $2^1/_2$, $3^1/_2$, and $4^1/_2$ inches in diameter, were fired in the inside bottom of the car where this condition developed.

The temperature measurements showed considerable lag on the bottom at the start, particularly on the inside, so much so that oxidation did not commence until 22 hours after entering the kiln, while at the top the same point was reached in eight hours. The gap between top and bottom gradually closed as the maturing temperature was approached, which brought about a condition where the bottom inside of the car passed rapidly through the latter half of the oxidation range. This seemed to be responsible for the blue coring condition, and it was necessary therefore to eliminate or at least reduce the lag in temperature at the bottom so that a more gradual rise in temperature through the oxidation stage would be obtained in this part of the cars.

This was accomplished by sealing the opening between the car frames with asbestos rope and by lighting additional furnaces, which had been idle, to increase the volume of combustion gases and to improve the gas movement around the individual insulators. This change increased the fuel consumption slightly. The sealing of the opening between cars reduced the cooling effect from the comparatively low temperature below the car. Temperature readings after these changes had been made showed that the bottom of the car reached the oxidation stage in 15 hours and the top in 7 hours as compared to 22 and 8 hours, respectively, prior to the changes, thereby reducing the temperature lag almost one-half. Attempts to reduce this lag further were unsuccessful, and this seemed to be about the best that could be done in view of the natural tendency for the top of the cars to heat first.

IX. Oxidation Control Methods

The effect of these changes on blue core conditions was definitely improved as indicated by the porcelain rods. Before the changes, the $3^1/_2$- and $4^1/_2$-inch rods were blue cored and the $2^1/_2$-inch rod had a slight amount. After they had been made, the $2^1/_2$-inch rod was entirely free of blue core and the $3^1/_2$-inch rod had only a slight amount. This indicated that commercial designs should be entirely free of this condition, and this conclusion was substantiated by actual results under the faster kiln schedule desired.

Note: The results of this investigation showed the

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[5] E. H. Fritz, "A Tunnel-Kiln Installation for Porcelain Insulators," *Jour. Amer. Ceram. Soc.*, **12** [11] 711–15 (1929).

[6] E. H. Fritz and H. M. Kraner, "The Rate of Oxidation of Porcelain and Ball Clays," *ibid.*, **12** [1] 1–13 (1929).

effectiveness of the porcelain rods as a check on oxidation conditions in the kiln, and they were, therefore, adopted as an item of control. These rods are now placed in the kiln at regular intervals so that a continuous periodic check is obtained on oxidation. With slower kiln schedules, this check is not important but it is made. The desired results are adjusted for the different schedules and in this way a check is available at all times as to whether the kiln is operating under the most favorable oxidation conditions possible. In addition, a recording CO_2 meter has been installed to provide a continuous check on combustion in general. The results with it have also been adjusted for different operating schedules and this entire problem is now under close control.

Some further improvement of this general condition has been obtained by the installation of small auxiliary burners where gas is used for fuel. These burners are usually located ahead of the furnaces at the bottom of the tunnel. By this means, it is possible to maintain the necessary volume of combustion gases for proper oxidation and they also make possible the supply of some of the heat units where and when they are particularly needed. The amount of fuel burned at the main furnaces is thereby considerably reduced, resulting in a net saving in fuel consumption, and there is a slight reduction in the lag in temperature between the bottom and the top. These burners are, therefore, further insurance against improperly oxidized porcelain.

X. Possibilities with Improved Cooling Methods

Some interesting results have been obtained in connection with a recent study of the progress of vitrification in the tunnel kiln. Porcelain test bars, 3/4 inch in diameter and 6 inches long, were withdrawn through the peepholes at various points along the hot zone and covered at once with sand until they were cool. Porosity and modulus of rupture determinations were then made.

Completely vitrified bars developed a modulus of rupture of 15,800 pounds per square inch. This compares with a value of 11,500 pounds for bars of the same size cooled in the usual manner or an increase in strength of more than 35%.

It was found that while the regularly cooled bars undergo a loss of strength of 30% when quenched from an oven at 170°C to water at room temperature, the bars withdrawn from the kiln and cooled in sand suffered no loss of strength on the same treatment.

At first, it was thought that this higher strength from the rapid cooling was due to a structural change in the porcelain. This was suggested because some of our microscopic work has indicated that the development of a crystalline structure is unfavorable to the strength of the porcelain. More recent work by the National Bureau of Standards, covering the effect of repeated heating on the strength of insulator porcelain, also supported this theory. It was shown that, after seven heats, long fine mullite needles were present which were not in evidence after one heat and the modulus of rupture was from 5 to 35% lower.[7] While no crystal structures can be seen after one heat on the basis of the regular firing and cooling cycle, the possibility existed that the rapid cooling brought about retardation of crystal growth below the microscopic range.

On further analysis, it appears more likely that the higher strength is associated with strains set up by the rapid cooling which compares with similar work with glass. This theory is supported by the fact that the rapidly cooled bars undergo a decrease in strength to 13,000 pounds when heated to 700°C. Attempts have been made to apply this treatment to actual insulator designs, but it has not proved successful as far as obtaining higher mechanical strengths is concerned. Small suspension insulators have been cooled from their vitrification temperature at cone 11 to 600°C in 50 minutes without cooling cracks and these gave the same mechanical and electrical values as normally cooled insulators. While the marked increase in strength as described above warrants further investigation of the possibilities of some practical advantage of this phenomenon, the diversity in electrical porcelain designs discourages its application.

XI. Further Possibilities with Variations in Kiln Atmosphere

Beyond the necessity of strongly oxidizing conditions during the heating-up period and the maintenance of low amounts of excess air in the hotter parts of the kiln in the interest of fuel economy, the factor of kiln atmosphere has not received a great deal of attention in electrical-porcelain firing.

Badger[8] has studied the effect of various gases on the vitrification behavior of feldspar bodies.

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[7] R. F. Geller, "Effect of Repeated Heatings on the Mechanical Strength of High-Tension Insulator Porcelains," *Bull. Amer. Ceram. Soc.*, **12** [1] 18–25 (1933).

[8] A. E. Badger, "Effect of Various Gaseous Atmospheres on the Vitrification of Ceramic Bodies," *Jour. Amer. Ceram. Soc.*, **16** [2] 107–17 (1933).

He found that water-vapor had a pronounced tendency to accelerate the rate of vitrification of such bodies.

Hossenlopp and Russell,[9] in firing mullite porcelain in a partial vacuum at a pressure of 0.3 inch of mercury, reached the point of maximum vitrification at a temperature 100°C lower than in oxygen at atmospheric pressure. We have observed a similar reduction in maturing temperature by firing electrical porcelain in a hydrogen diffusion furnace at 1.5 millimeters pressure. The mechanical strength of specimens so fired was equal to that of normally fired porcelains and the test values were somewhat more uniform for the vacuum-fired bars. Under present firing methods in direct-fired kilns where the products of combustion must be reckoned with, the possibilities with variations in kiln atmosphere are limited but we believe they warrant further attention. Possibly as electric firing is more generally adopted, this factor will become more important.

[9] A. M. Hossenlopp and R. Russell, "Effect of Furnace Atmosphere and Partial Vacuum upon the Vitrification of a High Mullite Porcelain," *Jour. Amer. Ceram. Soc.*, 18 [7] 204–205 (1935).

XII. Conclusion

In firing electrical porcelain at the present, defects caused by underfiring and overfiring are not encountered. The quality of the product has also been improved in other respects. Firing and cooling cycles have been reduced to 72 hours with tremendous economic advantages and maintenance of high-quality ware standards. This cycle is used for the complete line of designs which may vary at any one time from a small electric range bushing, weighing about one ounce, to a high-voltage condenser bushing casing, weighing as much as 500 pounds, indicating the degree of latitude permitted in the firing procedure.

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CERAMIC ABSTRACTS

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January, 1937

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Abrasives

Application of mechanical finishes to aluminum. R. T. Griebling. *Metal Cleaning & Finishing*, **8** [9] 615–20 (1936).—Mechanical finishes, such as polishing, burnishing, brushing, and tumbling, are described. Illustrated. E.J.V.

Automatic polishing machines. Fred B. Jacobs. *Metal Cleaning & Finishing*, **8** [9] 637–45 (1936).—Automatic machines for polishing and buffing metal parts are described in detail. Illustrated. E.J.V.

Causes of breakage of grinding disks. R. Uhlig. *Schleif- & Poliertech.*, **13** [3] 56–62 (1936).—U. describes the causes of breakage. Two series of illustrations show correct and incorrect setting-up of disks. F.E.V.

Continuous separation of abrasives. C. Benedicks and P. E. Wretblad. *Schleif- & Poliertech.*, **13** [3] 48–55 (1936).—An efficient schlamm (slurry) apparatus was built. Particles are distributed continuously from a container and fall in a tube where suspension is secured by a revolving screw. There are five successive tubes; the separation of the finest granules is obtained by projection. This set-up gives an excellent separation of abrasives without large grains. From commercial emery, it is easy to separate correctly granules of 2 to 4μ or 3 to 6μ intended for dry grinding. This schlamm process is also interesting for other techniques. Illustrated. F.E.V.

Determining hardness of abrasives. Henry R. Power. *Metal Cleaning & Finishing*, **8** [9] 627–28 (1936).—P. reviews and compares recent results of experiments to determine the hardness of natural and manufactured abrasives. E.J.V.

Education of grinders and abrasive engineers. P. Postel. *Schleif- & Poliertech.*, **13** [3] 47–48 (1936).—German workmen in the grinding industry usually do not possess the required ability. P. proposes the organization of practical tests at the Technical High School in Köthen and courses at the Institute for Grinding Techniques in Braunschweig. F.E.V.

Fracture of rotating brittle disks. H. Schlechtweg. *Ingenieur Arch.*, **6** [5] 365–72 (1935); abstracted in *Physik. Ber.*, **17** [3] 277 (1936).—A simple formula was derived to determine the "fracture velocity" of brittle rotating disks (grinding wheels). This velocity was found to be a linear function of the ratio $r_i/(r_o - r_i)$; r_o = outer diameter and r_i = inner diameter of the disk. M.H.

Granulometric determination of fine abrasives. C. Benedicks and P. E. Wretblad. *Schleif- & Poliertech.*, **13** [1] 1–5 (1936).—Usual determinations by the Werner process (sedimentation) are erroneous as shown by microscopic measures. This is caused by the nonvalidity of Stokes' law in this case. This law is applicable to a single particle in a liquid of unlimited dimensions but in no case to particles of the usual size in concentrated suspensions. A better method of determining dimensions by microsedimentation is given. A small quantity of material (1 mg.) is dropped through a liquid with a gradient of temperature intended to counteract, by variation of specific gravity, the effect of the stream. The weight of the sediment is determined by a microchemical method. Results agree with microscopic measures. F.E.V.

Grinding hard-faced surfaces. R. K. Kennedy. *Metal Cleaning & Finishing*, **8** [9] 621–26 (1936).—Proper wheels made by various abrasive wheel manufacturers for grinding surfaces hard-faced with Haynes Stellite, an alloy of cobalt, chromium, and tungsten, are listed according to the type of grinding to be done. The wheel speeds should not be less than 2800 nor more than 4200 surface ft. per min. E.J.V.

Improved Vanderwilt rock saw. G. D. Emich. *Amer.*

Mineralogist, **21** [10] 670–75 (1936).—Using 100-mesh Carborundum, 7-pound weights, and 190 strokes per min., the improved Vanderwilt rock saw cut quartz at the rate of about 1 in./hr., calcite at 4 in./hr., and quartz-sulfide ore at 2 in./hr. E. presents a detailed description of the saw. F.J.Z.

Isomorphous lamination in corundum and its importance for the separation of natural from synthetic corundum. A. SCHRÖDER. *Zentr. Mineral. Geol. A*, No. 5, pp. 129–35 (1936). H.I.

Origin of the emery deposits near Peekskill. JOHN W. BUTLER, JR. *Amer. Mineralogist*, **21** [9] 537–75 (1936).—Several theories have been proposed for the origin of the emery deposits associated with the Cortlandt series of basic plutonics which lies south and east of Peekskill, N.Y. These are as follows: (1) magmatic segregation, (2) absorption (assimilation) of aluminous sedimentary material (Manhattan schist), and (3) contact-metamorphism, under which two different stages of development have been considered: (*a*) hydrothermal contact-metamorphism and (*b*) deposition in marginally solidified endomorphosed norite and exomorphosed schist by emanations released from the still-liquid portions of the magma. Detailed field and petrologic studies of the emery have been made at Emery Hill where the principal deposits are located. New evidence disclosed objections to the earlier theories and led to the formulation of a revised theory of genesis. The emery deposits are believed to have been formed by emanations that were released by the magma during intrusion, and these emanations passed through the country rock (Manhattan schist) only a short distance in advance of the magma. Thus, the formation of emery took place during the early liquid-magmatic stage of the basic Cortlandt intrusives. Detailed descriptions of the emery, the rock types, and their relations are given. Reference is made to usage of the terms "hornfels" and "endomorphism" because of their significance to a study of the emery deposits. F.J.Z.

Principles governing selection of polishing wheels. ROBERT T. KENT. *Metal Cleaning & Finishing*, **8** [10] 713–18 (1936).—The general principles which underlie the adaptation of a wheel to the job to obtain the maximum production and finish at a minimum cost are (1) the character of the work, which includes the material and contour, (2) degree of finish required, and (3) precision with which the work must be finished. These principles may be used as a guide to the user of polishing wheels in determining the type best suited to his requirements. E.J.V.

Shape of abrasive grains. A. A. KLEIN. *Metal Cleaning & Finishing*, **8** [9] 550 (1936).—By proper milling steps it is possible to control the shape of the abrasive grain and vary it as desired. Industrial requirements are met by two shapes of grain; one is blocky or chunky, consisting of irregular, equidimensional grains, as well as thick wedges, and the other, while containing a predominant amount of chunky grains, shows a notable percentage of thinner wedges and flat and elongated grains. For sandpaper the grains are composed essentially of thin wedges, flakes, and elongated grains. E.J.V.

Surface testing instrument. ANON. *Z. Instrumentenk.*, **55** [12] 502–505 (1935); abstracted in *Physik. Ber.*, **17** [6] 683–84 (1936).—A microscope for rough service in the shop, which permits the comparison of polished or otherwise treated surfaces of materials with 30 to 70 magnification and permits the counting of pores, grooves, etc., is described. M.H.

BULLETIN

Abrasive materials industry in 1935. ANON. *Bur. Mines Mineral-Market Rept.*, MMS 468. 2 pp. Free. An advance summary is presented. R. A. HEINDL

PATENTS

Abrading device. N. H. KNOWLTON (United Shoe Machinery Corp.). U. S. 2,058,467, Oct. 27, 1936 (Aug. 16, 1934).

Abrasive belt. CARBORUNDUM CO. Brit. 453,851, Sept. 30, 1936 (May 21, 1934). R. H. JACKSON AND H. P. KIRCHNER (Carborundum Co.). U. S. 2,059,583, Nov. 3, 1936 (May 21, 1934).

Abrasive tools. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 453,344, Sept. 23, 1936 (May 15, 1935).

Adjusting device for cylinder grinders. F. M. KERN (Carborundum Co.). U. S. 2,058,464, Oct. 27, 1936 (Feb. 3, 1928).

Apparatus for buffing and polishing articles. C. R. MOON (Ontario Mfg. Co.). U. S. 2,055,665, Sept. 29, 1936 (June 7, 1935; Oct. 14, 1935).

Balancing apparatus. H. B. GIBBONS AND R. C. HOFF (Wingfoot Corp.). U. S. 2,058,784, Oct. 27, 1936 (June 2, 1934). A device for measuring the amount by which a rotatable object is out of balance is described.

Buffing wheel. M. I. DOYLE. U. S. 2,056,716, Oct. 6, 1936 (June 14, 1934).

Car wheel grinding device. H. A. LEONHAUSER (Carborundum Co.). U. S. 2,059,590, Nov. 3, 1936 (April 5, 1934).

Control mechanism for grinding machines. H. A. SILVEN (Norton Co.). U. S. 20,127, Oct. 6, 1936 (Aug. 12, 1936); reissue of U. S. 2,016,932, Oct. 8, 1935).

Device for grinding knives and scissors. W. GEVEKE. Brit. 454,482, Oct. 14, 1936 (May 23, 1936).

Eccentric grinder. A. L. DE LEEUW (Albert F. Nathan). U. S. 2,054,364, Sept. 15, 1936 (July 25, 1934).

Grinding or abrading machine. F. H. LLOYD & CO., LTD., AND W. DUDLEY. Brit. 452,931, Sept. 16, 1936 (March 12, 1935).

Grinding machine. H. L. BLOOD (Heald Machine Co.), U. S. 2,056,340, Oct. 6, 1936 (Dec. 1, 1931). C. S. CUSHMAN (Cushman Co.), U. S. 2,055,404, Sept. 22, 1936 (Feb. 15, 1934). F. E. GARDNER (Gardner Machine Co.), U. S. 2,056,182, Oct. 6, 1936 (Feb. 8, 1934). C. H. NORTON AND A. G. BELDEN (Norton Co.), U. S. 2,059,895, Nov. 3, 1936 (Oct. 3, 1931; renewed Feb. 24, 1936). E. C. OLIVER. U. S. 2,055,361, Sept. 22, 1936 (Feb. 15, 1934).

Grinding wheel. NORTON GRINDING WHEEL CO., LTD. Brit. 454,474, Oct. 14, 1936 (Dec. 19, 1934).

Grinding wheel truing apparatus. C. G. FLYGARE (Norton Co.). U. S. 2,056,148, Sept. 29, 1936 (Aug. 6, 1935).

Machine for grinding material. JOHN MCINTYRE. U. S. 2,057,307, Oct. 13, 1936 (June 19, 1935).

Machine for grinding cylindrical bodies. B. S. A. TOOLS, LTD., AND W. OGILVIE. Brit. 452,991, Sept. 16, 1936 (April 13, 1935).

Machine for grinding screw threads. H. LINDNER. Brit. 452,817, Sept. 9, 1936 (Dec. 21, 1934).

Manufacture of rubber-bonded abrasive articles. R. J. NOBLE (Heveatex Corp.). U. S. 2,057,733, Oct. 20, 1936 (Oct. 5, 1935). A method of making rubber-bonded abrasive products comprises mixing as separate entities or particles abrasive grain with substantially unvulcanized pulverulent rubber, molding the mixture under pressure into a unitary mass of the desired shape, and vulcanizing the molded mass.

Method of coating abrasive particles. H. M. DENT AND A. J. NORTON (General Plastics, Inc.). U. S. 2,059,983, Nov. 3, 1936 (June 27, 1932). The method of coating abrasive particles with a thermo-setting resinous material of lower melting point than the particles comprises moving the powdered resinous material upwardly in a current of a gaseous medium and dropping heated particles of abrasive downwardly through the current and the material whereby the heated particles come into contact with the resinous material, melting the resinous material and being enclosed thereby, the resinous material coating the particles being capable of hardening upon application of heat thereto.

Method of grinding cutter blades. JOSEPH GSTYR (Gleason Works). U. S. 2,057,303, Oct. 13, 1936 (Dec. 24, 1932; July 13, 1934).

Method of grinding and setting knives of cutting devices of cigarette machines. C. QUESTER AND K. QUESTER (trading as Kölner Werkzeug-Maschinenfabrik von W. Quester). Brit. 454,974, Oct. 21, 1936 (April 24, 1934).

Method and machine for lapping cutter blades. JOSEPH GSTYR (Gleason Works). U. S. 2,057,302, Oct. 13, 1936 (Dec. 24, 1932).

Portable grinding tool. E. S. MCGONEGAL. U. S. 2,055,302, Sept. 22, 1936 (March 7, 1936).

Reversing mechanism for machine tool table. W. W. TRIGGS (Norton Co.). Brit. 454,682, Oct. 21, 1936 (July 8, 1935).

Segmental grinding wheel. THURE LARSSON (Norton Co.). U. S. 2,054,771, Sept. 15, 1936 (Nov. 9, 1935).

Speed control mechanism for grinding machines. H. A. SILVEN (Norton Co.). U. S. 2,056,871, Oct. 6, 1936 (Nov. 29, 1932).

Tool for grinding conical bearings. G. W. HOLCOMB. U. S. 2,054,159, Sept. 15, 1936 (Nov. 13, 1935).

Truing apparatus. H. J. GRIFFING (Norton Co.). U. S. 2,056,149, Sept. 29, 1936 (Oct. 28, 1935).

Valve seat grinding tool. H. C. PRESTON (Black & Decker Mfg. Co.). U. S. 2,056,483, Oct. 6, 1936 (May 5, 1933).

Art and Archeology

Acoustic vases. J. CHATAING. *Nature* [Paris], No. 2, pp. 182–83 (1934).—C. describes resonant vases used in medieval times for resounding and modulating the voice of singers and orators in churches and in theaters. R.W.D.

Archeological research in southern Spain. MILDRED LATROBE-BATENAVE. *Discovery*, **17** [200] 233–35 (1936).—The work at Niebla of Mrs. Bernard Wishaw, founder of the Anglo-Spanish-American School of Archeology, is described and illustrated. H.H.S.

Ceramics in southern Africa. L. H. WELLS. *Anais de Faculdade de Ciencias do Porto*, **20** [1] 22–50; [2] 108–24 (1936).—A survey of the present knowledge of ceramics as developed from finds in southern Africa is attempted. Classification according to different regions was possible on the basis of the technique shown, and ethnological and historical relations are established. The earliest finds date back to at least 6000 B.C. and are of Bantu character. The ancestry of this pottery, however, could not be traced. 27 references. M.H.

Chinese origins. ANON. *Discovery*, **17** [200] 256–58 (1936).—The amazing accessions to knowledge resulting from the excavations at Anyang are summarized with special reference to the book, The Birth of China, by H. G. Creel of Chicago. H.H.S.

Color in candelabra. ANON. *China, Glass & Lamps*, **55** [7] 25 (1936).—There has been a sudden interest in lusters and crystal candelabra of the Victorian type. Metal is being replaced by glass, pottery, and china for accessories, indicating that glass candelabra will grow in popularity, offering possibilities for the glass manufacturer. G.M.P.

Excavations at Tall Chager Bazar. R. D. BARNETT. *Brit. Museum Quarterly*, **10** [3] 119–21 (1936).—At the lowest levels, belonging to the end of the Stone Age, the British Museum expedition found the highly-polished black pottery ornamented with white-filled incised markings resembling that at Knossos in Crete. At a higher level was Samarra ware and above that Tall Halaf ware. H.H.S.

First natives of South Africa. G. A. GARDNER. *Discovery*, **17**, 178–81 (1936).—An Archeological Bureau of S. Africa has been formed with van Riet Lowe as director. The excavations at Mapungabwe, Transvaal, of which G. is field director, are under the ægis of Pretoria University. The pottery found proves that the first tribes to enter S. Africa were of Sotho stock and that these were supplanted by the Shona, whose ceramic work is very fine. H.H.S.

Glass models of invertebrates. FRANK LONG. *Bull. Amer. Ceram. Soc.*, **15** [11] 405–407 (1936).

Instructions for printing ceramic decalcomania. G. M. PETERSEN. *Bull. Amer. Ceram. Soc.*, **15** [11] 392–96 (1936).

Is stained glass a lost art? LAWRENCE SAINT. *Bull. Amer. Ceram. Soc.*, **15** [11] 375–82 (1936).

Italian majolica and the terminology of colors. A. DEL VITA. *Corriere Ceram.*, **17** [1] 3–11 (1936).—The names and terms used to designate colors and glazes of medieval and renaissance majolicas are explained in detail. M.V.C.

Lambeth delft bust of King Charles I. WILLIAM KING. *Brit. Museum Quarterly*, **10** [3] 131 (1936).—The Museum has acquired an example of Lambeth delft which is believed to be an earthenware reproduction of the marble bust of Charles I by Bernini. H.H.S.

Lusters. ANON. *China, Glass & Lamps*, **56** [1] 24 (1936).—Lusters, very popular during the early 19th Century, are again being made commercially, especially silver luster. John Hancock, shortly after 1769, made the

first lusters in England. Silver and copper were first used, followed by pink, purple, and other tints. Some pieces were coated entirely, resembling solid silver, and others had a white design on a silver background. G.M.P.

Manufacture of ceramic decalcomania. G. H. STAPLEFORD. *Bull. Amer. Ceram. Soc.*, **15** [11] 383–91 (1936).

Modern English decoration. D. MORAND. *Clarté*, **8** [4] 1–5 (1935).—Modernism develops more slowly in the British Islands because "British modernism" is waiting for decisive results in the matter before creating an art that would not permit standardization. Illustrated. R.W.D.

New light on ancient Assam. J. P. MILLS. *Discovery*, **17**, 204–206 (July, 1936).—Mon-Khmer megalithic urns found on a remote plateau link up Assam with the ancient widespread culture which covered Australasia from Madagascar to S. America. H.H.S.

Old and new glass on display. W. R. STOREY. *N. Y. Times Mag.*, Oct. 18 (1936).—The exhibition of glass at the Metropolitan Museum included glass vases, platters, bottles, pitchers, and bowls from the earliest known pieces dating about 1500 B.C. to the most recent productions. Some of these are described. M.V.C.

Pottery industry in Muskingum County, Ohio. JOSEPHINE GITTER. *Bull. Amer. Ceram. Soc.*, **15** [10] 371–72 (1936).

Pottery in secondary schools. WALTER R. WILLIAMS. *Design*, **38** [3] 11–14 (1936).—The development of avocational interests, the achievement of æsthetic interpretations, the discovery of historical and modern consumer values, and the occasional maturing of specific vocational interests justify the study of ceramics in secondary schools. The work in Haaren High School in New York and in Flowers Technical High School in Chicago is illustrated. E.B.H.

Progress in archeology. E. N. FALLAIZE. *Sci. Progress*, **31** [121] 130 (1936).—The subjects reviewed are (1) absolute chronology in prehistory (see "Mesolithic—," this issue), (2) Hellmut de Terre's work on early man in India, (3) F. E. Zeuner's work in central Europe, (4) A. E. Douglass on the Pueblo Indians of Southwest U. S., and (5) Ireland. H.H.S.

Road to empire: II. J. JOHNSON. *Sci. Amer.*, **155**, 10–11 (1936).—When lightning struck the forum of Minturnae about 40 B.C. the priests dug an expiatory well and buried samples of the buildings destroyed, such as brightly colored terra cotta roof tile and covers, a section of a column, two capitals, a winged victory statue, and pieces of an altar. This was completely excavated. For Part I see *Ceram. Abs.*, **15** [8] 228 (1936). W.D.F.

Robineau Memorial Ceramic Exhibition prize winners. ANON. *Bull. Amer. Ceram. Soc.*, **15** [11] 408 (1936).

Rockingham. ANON. *China, Glass & Lamps*, **55** [7] 46 (1936).—The Rockingham factory was founded in 1745 and operated about 100 years. It is best known today for its "brown china," especially teapots. The body was cream-colored covered with a purple-brown glaze colored by manganese and iron. The color was delicately varied through repeated dippings. G.M.P.

Sèvres porcelain vases. WILLIAM KING. *Brit. Museum Quarterly*, **10** [3] 130 (1936).—Two vases have been donated to the Museum which are adorned with the so-called "jewelled decoration" of applied enamel. The vases are 12.5 in. high, and it is exceptional to find this decoration on genuine Sèvres of larger size than cups and saucers. Illustrated. H.H.S.

Stained and sculptured glass in churches. G. B. J. ATHOE. *Parthenon; Notes & Queries*, **170**, 354 (May 16, 1936).—Following the objection of an English bishop that stained glass unduly darkens a church, Allen Howes, a Bristish sculptor, has introduced sculptured plain glass. His process is described, and specimens of his work are illustrated. H.H.S.

Trends in the dining room. ANON. *China, Glass & Lamps*, **56** [1] 31–34 (1936).—The china and glassware market will probably be affected by trends in related fields such as furniture, upholstery, table linens, etc. Popular colors for house furnishings include yellow and brown in many shades, deep red, plum, sage green, deep blue, etc. Colors in general have been grayed, with more definite colors used as accents. Table linens trend toward deeper toned colors, particularly brown and blue. Apricot shades are becoming popular with white and pale ivory for more formal use. Smaller dining space in many modern homes will affect selection of tableware. G.M.P.

Vitrified overglaze, opacifiers, colorants. EÇA DUARTE VIEIRA. *Rev. Chimica Industrial*, Oct., Dec. (1934); Jan. (1935).—V. mentions chemical materials which are used as overglazes in ceramic ware. A.K.S.

Why not Australian porcelain? J. A. VERMESS. *Clay Prod. Jour. Australia*, **3** [11] 17–19, 29 (1936).—V. maintains that Australian art should become distinctively Australian. Allusion is made to patriotism fostered by art in the U.S.A., as exemplified in the display of 11 stained glass windows depicting the Byrd Antarctic expedition and other national events at the Kaufmann store at Pittsburgh. H.H.S.

Year's excavations at Lachish. E. N. FALLAIZE. *Discovery*, **17** [200] 250–51 (1936).—The 1935–36 operations of the Wellcome expedition, under J. L. Starkey, at Tell Duweir (ancient Lachish), 25 miles southwest of Jerusalem, are described. A Helladic goblet with ivyleaf decoration is illustrated. H.H.S.

BOOKS

English Art and English Society. T. ASHCROFT. Peter Davies, London, 1936. Reviewed in *Sydney Morning Herald*, Sept. 26, 1936.—A study is made of the arts as conditioned by social environment. H.H.S.

Mesolithic Settlement of Northern Europe. J. G. D. CLARK. Cambridge Univ. Press, 1936. Price 25s. Reviewed in *Discovery*, **17**, 262 (1936); *Sci. Progress*, **31**, 132 (1936).—The book covers the gap between paleolithic man and neolithic man equipped with pottery. An exact chronology is attempted by using de Geer's clay-varve method (See "Dating—" *Ceram. Abs.*, **15** [1] 37–38 (1936)). H.H.S.

Progress of Archeology. STANLEY CASSON. G. Bell and Sons, London, 1934. 110 pp. Price 6s. Reviewed in *Geographical Jour.*, **85** [3] 294 (1935).—A rapid survey of archeological knowledge gained from excavations during the last twenty years is given. F.G.H.

Twentieth Century Ceramics. GORDON FORSYTH. *Studio* [New York], Special No., Sept., 1936. 200 illus-

trations. F. has collected choice examples of the products of America and Europe and these are reproduced in monochrome and color. He discusses the special qualities of present-day design and technique, and compares them with the practice of the past. A brief description of process of pottery manufacture is given for the benefit of laymen and collectors, and the basic merits of the shapes are explained. Tableware, kitchenware, vases and decorative pieces, and pottery sculpture are represented under group headings. This book is a reference work for potters, pottery designers, pottery schools, and libraries.

PATENTS

Designs for:

Ashtray. Du Pont Cornelius (Kensington, Inc.). U. S. 101,211, Sept. 15, 1936 (Dec. 7, 1935).

Bath spout. Henry Dreyfuss (Crane Co.). U. S. 101,443, Oct. 6, 1936 (May 15, 1936).

Bathtub. Henry Dreyfuss and R. H. Zinkil (Crane Co.), U. S. 101,447, Oct. 6, 1936 (May 15, 1936). W. J. Kohler and G. K. Geerlings. U. S. 101,636, Oct. 20, 1936 (Aug. 22, 1936).

Bracket. H. K. Kimble (Kimble Glass Co.). U. S. 101,585, Oct. 13, 1936 (June 17, 1936).

Brick for wall construction. Joseph Iannone. U. S. 101,634, Oct. 20, 1936 (July 3, 1936).

Bottle. W. R. Kohl (Carr-Lowrey Glass Co.), U. S. 101,538, Oct. 13, 1936 (Aug. 17, 1936). U. S. 101,539, Oct. 13, 1936 (Aug. 20, 1936). J. S. Steelman (Whitall Tatum Co.), U. S. 101,419 and 101,420, Sept. 29, 1936 (July 21, 1936).

Bowl. B. N. Kane (Hall China Co.). U. S. 101,777, Nov. 3, 1936 (May 26, 1936).

Chemical toilet. J. R. Morgan (Sears, Roebuck & Co.). U. S. 101,238, Sept. 15, 1936 (July 8, 1936).

Combined lavatory and pedestal. Henry Dreyfuss and R. H. Zinkil (Crane Co.). U. S. 101,446, Oct. 6, 1936 (May 15, 1936).

Cup. R. G. Cowan (Onondaga Pottery Co.). U. S. 101,619 and 101,620, Oct. 20, 1936 (July 31, 1936).

Deviator spout. Henry Dreyfuss (Crane Co.). U. S. 101,444, Oct. 6, 1936 (May 15, 1936).

Flower holder. W. C. McCartney. U. S. 101,234, Sept. 15, 1936 (July 28, 1936).

Gas range. D. L. Hadley. U. S. 101,735 to 101,737, Oct. 27, 1936 (June 24, 1936).

Glass ashtray. T. C. Heisey. U. S. 101,630, Oct. 20, 1936 (March 6, 1936).

Glass building block. J. R. Hoge (Owens-Illinois Glass Co.), U. S. 101,633, Oct. 20, 1936 (March 20, 1936). E. P. Lockart, Jr. (Owens-Illinois Glass Co.), U. S. 101,372, Sept. 29, 1936 (Jan. 31, 1936).

Glass globe. T. W. Rolph (Holophane Co., Inc.). U. S. 101,557 and 101,603, Oct. 13, 1936 (Aug. 14, 1936). U. S. 101,823 and 101,824, Nov. 3, 1936 (Sept. 11, 1936).

Glass plate. H. H. Blau. U. S. 101,612, Oct. 20, 1936 (May 7, 1936). Walter von Nessen (A. H. Heisey & Co.), U. S. 101,410, Sept. 29, 1936 (July 29, 1936).

Goblet. J. D. McKee (Pope-Gosser China Co.). U. S. 101,379, Sept. 29, 1936 (July 23, 1936).

Jar. Frasier Smith (Hazel-Atlas Glass Co.), U. S. 101,563, Oct. 13, 1936 (Aug. 14, 1936). J. F. Toner (Owens-Illinois Glass Co.), U. S. 101,746, Oct. 27, 1936 (Aug. 27, 1936).

Lavatory. Henry Dreyfuss and R. H. Zinkil (Crane Co.). U. S. 101,445, Oct. 6, 1936 (May 15, 1936).

Pie plate. Louis Poglein. U. S. 101,242, Sept. 15, 1936 (June 25, 1936).

Pitcher. H. H. Boyce. U. S. 101,207, Sept. 15, 1936 (July 15, 1936).

Plate. Yukio Buma (Morimura Bros., Inc.), U. S. 101,269 and 101,270, Sept. 22, 1936 (Jan. 24, 1936). R. G. Cowan. U. S. 101,520, Oct. 13, 1936 (July 31, 1936). C. W. Leigh (Morimura Bros., Inc.), U. S. 101,588, Oct. 13, 1936 (June 2, 1936). J. D. McKee (Pope-Gosser China Co.), U. S. 101,380, Sept. 29, 1936 (July 23, 1936).

Puree bowl. R. G. Cowan. U. S. 101,519, Oct. 13, 1936 (July 31, 1936).

Range. J. C. Rogers (Crown Stove Works). U. S. 101,714 and 101,715, Oct. 27, 1936 (March 12, 1936).

Water closet. Henry Dreyfuss (Crane Co.), U. S. 101,441, Oct. 6, 1936 (May 15, 1936). Clarence Karstadt (Briggs Mfg. Co.), U. S. 101,534 to 101,536, Oct. 13, 1936 (Aug. 27, 1936).

Cements

Calcium sulfate hemihydrate obtained by evaporation, and polymorphism of anhydrous calcium sulfate. P. Gaubert. *Bull. Soc. Franç. Minéral.*, **57** [7–8] 252–67 (1934).—Crystals of $CaSO_4 \cdot {}^1/_2H_2O$, obtained by evaporation of a warm HNO_3 solution, are composed of hexagonal prismatic forms belonging to the rhombohedral system, the basal faces often truncated. They frequently show optical anomalies consisting of three birefringent basal sections with variation of 2E from 6 to 35°. Crystals dehydrated in air at 130°C or in a neutral liquid at 170°C preserve their form and optical orientation, but the birefringence varies irregularly. The water is not constitutionally the same as zeolitic water. Anhydrous $CaSO_4$ is trimorphous. Soluble anhydrite ($\gamma CaSO_4$), formed by heating the $CaSO_4 \cdot {}^1/_2H_2O$ at about 180°, is composed of three series of lamellas parallel to the sides of the hexagonal prisms of the hemihydrate. The lamellas are optically biaxial (2E about 50°) with the plane of the optic axes perpendicular to the hexagonal base and the acute bisectrix parallel to the vertical axis. $\beta CaSO_4$ has density = 2.85, $\gamma = 1.595 \pm 0.003$, $\alpha = 1.562 \pm 0.003$. It is stable up to 520°C and inverts to the α form (natural anhydrite) above this temperature. H.I.

Constitution of Portland cement and aluminous cement. A. Travers. *Verre & Silicates Ind.*, **7** [13] 150–54; [15] 174–78; [17] 199–202; [18] 210–13; [20] 234–38; [21] 245–51 (1936); for abstract see *Ceram. Abs.*, **14** [3] 61 (1935). M.V.C.

Crystal structures of gypsum, $CaSO_4 \cdot 2H_2O$. W. A. Wooster. *Z. Krist.*, **94** [5] 375–96 (1936).—The structure of gypsum was investigated, using ionization spectrometer measurements and oscillation photographs. The

structure is of the layer-lattice type, and the layers of Ca and SO_4 ions are separated by planes of H_2O molecules. Ca is surrounded by 6 SO_4 and 2 water molecules; the sulfur is at the center of an oxygen tetrahedron, and the water molecules have 2 oxygens and one calcium as their first neighbors. The structure explains qualitatively the perfect, fibrous, and imperfect cleavages, the anisotropy in the thermal expansion, the orientation of the optical indicatrix, and the change of the optic axial plane on raising the temperature. H.I.

Dehydration of gypsum. WILHELM BÜSSEM, OSKAR COSSMANN, AND CARL SCHUSTERIUS. *Sprechsaal*, **69** [28] 405–406; [29] 421–22; [30] 433–34; [31] 443–45 (1936).—The escape of water from pores became noticeable at 45°C and reached its maximum at 75°. The transformation of gypsum dehydrate ($CaSO_4 \cdot 2H_2O$) into gypsum hemihydrate ($CaSO_4 \cdot {}^1/_2H_2O$) begins at 95° and reaches a maximum at 98 or 100° (commercial plaster of Paris and precipitated gypsum). This transformation begins at 110° or higher and ends at 130° in the case of rock gypsum formed under pressure. The transformation of $CaSO_4$ occurs at about 150° and reaches a maximum at 180° with plaster of Paris and rock gypsum. The transformation of plaster of Paris into $CaSO_4$ begins at 230 or 250° and is ended at 400°. The sintering of natural anhydrite begins at 450° and rapidly increases at over 500°. M.V.C.

Development of cement research in 1935. C. R. PLATZMANN. *Zement*, **25** [17] 285–90; [18] 299–302 (1936).—The fundamentals are given. The standards are published quickly. International unification is highly desirable. The mechanical determination of cements should be substituted by a chemical determination. P. gives an outline of papers dealing with analysis, tests, scientific research, manufacture, and corrosion of cements. Patent literature is not considered. F.E.V.

Effect of blending Portland and aluminous cements. E. RENGADE. *Rev. Mat. Constr. Trav. Pub.*, No. 300, pp. 255–56 (1934); translated in *Concrete* [Cement Mill Ed.], **44** [3] 40–41 (1936).—This is a criticism of work by Dorsch (*Ceram. Abs.*, **12** [7] 253 (1933)) and by Merciot. Dorsch obtained quick setting at all proportions, and R., between 40 and 90% aluminous (Lafarge) cement. The right mixtures of Lafarge and Portland cement will have any set desired and be nearly as strong as the Portland. Dorsch says these mixtures are disintegrated by sea water, but R. states that some have been exposed ten years without damage. A list of successful structures built with the mixture is given. W.D.F.

Effect of various fluorides on the thermal combination of Portland cement raw mixtures. S. NAGAI AND M. TAKAHARA. *Jour. Soc. Chem. Ind. Japan*, **39** [6] 183–84B (1936).—The results are compared in tables. M.V.C.

Heat exchange of several reactions which occur in the synthesis of Portland cement. OTTO FR. HONUS. *Zement*, **24** [48] 761–63; [50] 793–95; [52] 823–24 (1935); **25** [3] 33–38 (1936).—To determine heat exchange of chemical reactions, three methods are possible: (1) mathematical utilization of thermal analysis, (2) determination of differences of the solution heats between components and compounds, and (3) calculation of heat exchange from chemical equilibrium pressures. The first two methods are easier; the third one requires exact measures of pressure and temperature. H. has elaborated a formula giving pressure up to 1553°K. The formation of monocalcium ferrite, starting from the elements Ca, Fe, and O_2, evolves 345.54 cal./mol.; starting from CaO and crystallized Fe_2O_3, it evolves 18.85 cal.; from limespar and Fe_2O_3 23.43 cal. The formation of monocalcium aluminate from elements evolves 528.618 cal., from CaO + γAl_2O_3, 16.62 cal., and from aragonite + γAl_2O_3, 25.96 cal. The formation of $MgO \cdot SiO_2$ from elements gives 359.48 cal., from MgO + crystallized SiO_2, 9.68 cal., from MgO + amorphous SiO_2, 13.18 cal., and from precipitated $MgCO_3$ + amorphous SiO_2, 10.9 cal. In blast-furnace slags, when slowly cooled, 3 kinds of silicates are found: (1) orthosilicates of the olivine series, (2) metasilicates such as augite, pyroxene, and wollastonite, and (3) gehlenite, akermanite, and melilite. The formation of gehlenite, $3CaO \cdot Al_2O_3 \cdot 2SiO_2$, from $CaSO_4$ and metakaolin, $Al_2O_3 \cdot 2SiO_2$, is discussed. The formation of gehlenite from elements gives 1222.01 cal., from sulfate and metakaolin, 251.22 cal. F.E.V.

Heat of formation of tricalcium silicate at 1300°C. H. E. VON GRONOW. *Zement*, **25** [5] 61–62 (1936).—Decomposition of $3CaO \cdot SiO_2$ to $2CaO \cdot SiO_2$ and CaO does not occur at room temperature, the velocity of reaction being practically nil. G. determines the heat of formation of trisilicate at 1300° by two different methods and finds 0.13 cal./mol. or 2.06 cal./g., the initial bodies being β-$2CaO \cdot SiO_2$ and CaO. In clinker manufacture this heat effect is absolutely negligible. X-ray investigation shows little difference between $3CaO \cdot SiO_2$ and a mixture of β-$2CaO \cdot SiO_2$ + CaO. In this case, the endothermic formation of trisilicate should evolve a body of lower specific gravity than the constituents. Specific weights are CaO 3.31, disilicate 3.28, and trisilicate 3.25. F.E.V.

Investigations on celite: I. Y. SANADA. *Jour. Soc. Chem. Ind. Japan*, **39** [5] 158B (1936).—The preparation and hydraulic properties of high celite cement were studied. S. concludes that (1) the firing temperature of clinker decreases and the setting time of cement is accelerated as the celite in the clinker increases, and (2) the tensile strength of 1:3 cement-sand mortar increases and the compressive strength decreases as the celite in the clinker increases. M.V.C.

Manufacturing process for clinkerless slag cement. P. P. BUDNIKOV. *Concrete* [Cement Mill Ed.], **44** [9] 35–37 (1936).—B. gives a description of raw materials and process. A quickly cooled blast-furnace slag, CaO and Al_2O_3 not less than 45% and 8% and MnO and Fe_2O_3 not more than 3% and 2%, is granulated either wet or dry, size not to exceed 6 mm. or 15 mm., respectively. The color must be light or bright and the mineralogical composition not less than 90% glass. To accelerate hardening, burned dolomite (5%), natural or artificial anhydrite (5%), and gypsum (2%) are added, making a total of 12% admixtures and 88% slag. This is ground in a three-compartment tube mill until 88% passes the 4900-mesh sieve (178 meshes/in.). W.D.F.

Ore cement or iron cement: V. S. NAGAI AND K. NOMI. *Jour. Soc. Chem. Ind. Japan*, **38** [12] 737–39B (1935).—Tables show the following: (1) analyses of the chemical composition on samples of common Portland

cements; (2) results of stability, compression strength, loss on ignition, and free lime in hardened cement paste; and (3) results of tests on the strength of prismatic test pieces cured in agressive salt solutions. **VI.** S. NAGAI, K. NOMI, AND K. INOUE. *Ibid.*, **39** [7] 215–17B (1936).—The expansion or contraction of length during hardening of cement sand mortar was tested on prismatic test pieces of 1:1:2 plastic mortar cured in water, 10% Na_2SO_4, and 10% NaCl solutions for 35 weeks. The results are tabulated. The corrosive action on the mortar strength of prismatic test pieces cured as above was tested by comparing the binding and compressive strength after measuring their expansion or contraction, and the results are given in tables. For Parts **I–III** see *Ceram. Abs.*, **15** [5] 143 (1936). M.V.C.

Petrofabric analysis of gypsum. H. W. FAIRBAIRN. *Z. Krist.*, **92**, 321–42 (1935). F.I.

Portland cement. Effects of catalysis and dispersion. H. L. KENNEDY. *Ind. Eng. Chem.*, **28** [8] 963–69 (1936).—Advantages are obtained by catalytic and dispersing agents. Without changing the nature of cements, the technique of the manufacture of cement and concrete can be improved by the addition of minute amounts of properly chosen materials. Illustrated. F.G.H.

Pottery plaster. A. HEATH. *Trans. Ceram. Soc.*, **35** [6] 286–99 (1936).—H. describes briefly the manufacture of pottery plaster and discusses the effect of factors such as storage, blending, proportioning, and expansion on mold life. R.H.H.P., JR.

Producing cement and iron in a rotary kiln. A. MARGARIT. *Concrete* [Cement Mill Ed.], **44** [3] 42–43 (1936).—This kiln is in operation on a commercial scale near Barcelona, Spain. Calcareous and argillaceous materials are put in a 9- x 140-ft. rotary kiln after being finely ground and moistened. Burned pyrites are mixed with the coal and burned. The carbon monoxide reduces the ferric iron. When hot enough, clinkering forms a slag which is a good Portland cement. A ring dam retains the iron. The kiln produces 50 tons of cast iron and 80 tons of Portland cement clinker instead of the 150 tons of clinker previously produced. The clinker is of excellent quality and contains only 1 or 2% iron. The cast iron analyzes C 4.061%, Si 0.187%, Mn 0.102%, S 0.007%, and P 0.059%. W.D.F.

Reaction between kaolin and $Ca(OH)_2$. P. P. BUDNIKOV. *Concrete* [Cement Mill Ed.], **44** [3] 35–37 (1936).—B. gives the results of treating calcined kaolin with a saturated solution of $Ca(OH)_2$. Ten gram samples of kaolinite were heated in a platinum crucible to 500, 600, 700, 750, 800, 850, 900, 1000, 1100, and 1150°C for one hour and cooled quickly. The first three had decreasing amounts of water. A Bunsen isothermal calorimeter was used to measure the heat of reaction. The most heat is given off by the kaolin fired to 800 to 900°C; no heat is given off when it is fired above 1100°C. The calcined kaolin reacts with the $Ca(OH)_2$ to form a hydrate. W.D.F.

Solved and unsolved problems of Portland cement clinker. HANS KÜHL. *Tonind.-Ztg.*, **60** [48] 591–93; [49] 607–609 (1936).—The chemistry of Portland cement is discussed in detail. M.V.C.

Structural characteristics of some constituents of Portland cement clinker. HERBERT INSLEY. *Jour. Research Nat. Bur. Stand.*, **17** [3] 353–61 (1936); R.P. 917. Price 5¢.—Preliminary observations on the constituents of Portland cement clinker by the petrographic and metallographic microscopes are recorded. The lack of purity of $3CaO{\cdot}SiO_2$ in some commercial clinker is demonstrated. The structures of $2CaO{\cdot}SiO_2$ in commercial clinker and laboratory preparations are illustrated, and it is suggested that differences in optical properties of specimens of dicalcium silicate may be due to twinning and not to the existence of the alpha modification at room temperatures. Glass may be present in at least one type of cement clinker. R.A.H.

Use of aluminum and slag cement mixtures as rapidly setting hydraulic mortars. ANON. *Génie Civil*, **108** [18] 416–18 (1936).—In cases where rapid setting is required, such as waterproofing large areas subjected to water seepage, a mixture of aluminum cement with cements made of slag is recommended. Its setting time is less than one minute. J.D.G.

BOOK

Chemistry of Portland cement (Zur Chemie des Portlandzementes). LENNART FORSÉN. Zementverlag, Berlin-Charlottenburg, 1935. 84 pp. Price 3.60 Rm. Reviewed in *Tonind.-Ztg.*, **60** [44–45] 563 (1936).—F. discusses present-day studies and describes a series of results of his experiments. See *Ceram. Abs.*, **15** [3] 82 (1936). M.V.C.

PATENTS

Cement. D. S. HUBBELL (H. H. Robertson Co.). U. S. 2,058,985, Oct. 27, 1936 (Oct. 3, 1935). A new article of manufacture comprises the cement resulting from the treatment of a partially calcined dolomite containing a small amount of lime and finely divided copper with a solution of magnesium chloride.

Cementitious material. D. S. HUBBELL (H. H. Robertson Co.). U. S. 2,058,984, Oct. 27, 1936 (Oct. 12, 1934). A cementitious material possessing improved weather resistance comprises a cement of the Sorel type containing finely divided copper in an amount substantially less than the amount of the cement.

Cementitious material. D. S. HUBBELL (H. H. Robertson Co.). U. S. 2,058,986, Oct. 27, 1936 (Feb. 13, 1936). A new article of manufacture comprises the cement resulting from the treatment of a partially calcined dolomite containing a small amount of lime and finely divided cuprous oxide with a solution of magnesium chloride.

Cementitious material. D. S. HUBBELL (H. H. Robertson Co.). U. S. 2,058,987, Oct. 27, 1936 (Feb. 13, 1936). A cementitious material possessing improved weather resistance comprises a cement of the Sorel type containing finely divided cuprous oxide in an amount substantially less than the amount of the cement.

Method and apparatus for feeding cement kilns. F. A. B. FINKELDEY. U. S. 2,054,156, Sept. 15, 1936 (April 9, 1935).

Enamel

Annealing in controlled atmospheres. W. A. DARRAH. *Ind. Heating*, **3** [10] 671–78, 701–702 (1936).—Economic advantages of using controlled atmospheres in heat-treating processes, especially in bright-annealing, are discussed, and furnace details are described. M.H.

Application of theories of the glass state to special properties of enamel. FRIEDRICH HEIMES. *Sprechsaal*, **69** [8] 103–106 (1936).—Glass particles of a glass with large molecules often adsorb more gas on the surface than those of a glass with smaller molecules. An amorphous or finely crystalline material of the same weight adsorbs more than an originally coarsely crystalline material which is finely powdered. An approach to the crystalline field occurs through the addition of mineralizers when glass brick is crushed; this fact is connected with a decrease in adsorption. Because only small variations in the adsorption capacity were determined, H. assumes that the degree of viscosity is of the greatest importance for the behavior of enamel. Large molecules should be present in enamels opacified with gas. See *Ceram. Abs.*, **15** [8] 232 (1936). M.V.C.

Basic chemical for making up cleaning mixtures. PENNSYLVANIA SALT MFG. CO. *Metal Cleaning & Finishing*, **8** [9] 657 (1936).—Orthosil (the anhydrous sodium orthosilicate) in hot solutions will remove all types of soil usually found on steel except that removed by pickling. Orthosil solutions have a high dissolving power on grease and dirt, holding them in suspension after removing them from the metal and preventing redeposition of the soil on the cleaned material. E.J.V.

Calculations in enamel technique. VIELHABER. *Emailwaren-Ind.*, **13** [34] 277–78 (1936).—The difficulty of finding various properties of enamel by means of calculating different factors is pointed out. The calculated value of elasticity is entirely unreliable. The calculation of specific gravity has no practical significance. Tensile strength and resistance to pressure are greatly affected by the formation of bubbles, and the calculated values are without significance. M.V.C.

Cements for bonding sands for foundry purposes. M. PASCHKE, C. WEYMANN, AND E. SCHNEIDER. *Giesserei*, **23** [17] 381–86 (1936).—Cement-sand mixtures were investigated with regard to their suitability for molding for foundry purposes. The permeability for gas is good, mechanical strength excellent, and they are sufficiently fire-resistant. They can be used again after crushing and adding new cement. The sand should be as sharp as possible and free of harmful impurities. The tests and a method for determining permeability for gases are described. M.H.

Colored cast-iron wet enamel. HUGO SCHULZE. *Glashütte*, **66** [36] 621–22 (1936).—The effect on colored enamels of various factors, such as the kind of enamel used, opacification, kind of pigment, firing temperature, grinding, duration of grinding, and effect of gases during firing, is briefly discussed. M.V.C.

Coloring oxides and how they are affected by variations of enamel composition. W. BALL. *Sheet Metal Ind.*, **10** [106] 145–46, 148 (1936).—B. discusses the manufacturing process and stability of coloring oxides, color variation difficulties met with, and the types of enamel suitable for carrying coloring oxides. A.P.S.

Control in enamel works. ANON. *Keram. Rundschau*, **44** [7] 74–78; [8] 89–92 (1936).—This control is relatively simple and concerns raw materials, melting of enamels, mill and slip, and manufactured ware. These are discussed in detail. F.E.V.

Delayed ground-coat blistering. G. H. SPENCER-STRONG AND JAMES J. THEODORE. *Jour. Amer. Ceram. Soc.*, **19** [11] 328–30 (1936).

Determining iron in pickling acid. ROGERS K. TAYLOR. *Amer. Enameler*, **9** [5] 23 (1936).—Every factor in the porcelain enameling process is important. A desirable supplement to the determination of acidity in pickling acid is the determination of the iron content. T. describes various indicators. J.H.S.

Drier for foundries. SCHMIDT. *Giesserei*, **23** [14] 341–42 (1936).—Modern installations for drying molds and cores are described. M.H.

Effect of borax mill additions to a ground coat. JAMES J. THEODORE. *Amer. Enameler*, **9** [6] 10 (1936).—The results of a comprehensive study of the reactions of borax as a mill addition to a ground coat are given. J.H.S.

Electrical heat in the foundry. K. MERTENS. *Elektrowärme*, **6** [9] 254–57 (1936).—The advantages of using heat produced without combustion products in many industrial processes are discussed, and a few types of modern electric furnaces for the metallurgical industry, especially for foundry purposes and annealing, are described. M.H.

Enamel coatings in theory and practice. J. PERMANN. *Berg- & Hüttenmännisches Jahrbuch*, **84** [2] 77–82 (1936).—The conditions which assure a good, well-adhering enamel coating on metals are discussed. The usual process is (1) to coat the metal with an enamel or vitreous material to which is added a flux consisting of different metal oxides able to form an intimate bond with the metal, and (2) to put on this ground layer the actual enamel having the properties required in each special case. The best oxides for this purpose are CoO, NiO, and MnO_2. The strong adhesion is due to the chemical reactions between the iron oxides of the metal which are soluble in the enamel and thus form an intimate joint. The enamel coating usually consists of siliceous materials (quartz, feldspar, clay), fluxes (borax, boracic acid, fluorspar, cryolite, fluorsodium silicide, soda), coloring matter and opacifiers, and decolorizing agents (saltpeter, manganese oxide, etc.). The best composition for cast iron which is to be enameled is 3 to 3.5 C, 2 to 2.6 Si, 0.3 to 0.6 Mn, 0.7 to 2 P, and 0.07 to 0.2% S, and that for sheets is 0.06 to 0.08 C, 0.05 to 0.1 Si, 0.08 to 0.4 Mn, less than 0.1 P, and less than 0.05% S. Methods for testing the resistance of enamels against chemical attack are described, and fields of application for enameled ware are discussed. The thinner the enamel layer can be made, the greater is the protective action of an enamel layer against chemical action. The attack on enamel by acetic acid is used as a test; it is strongest at a concentration of 20%, while on steel sheet the attacking action increases with the concentration. 6 references. M.H.

Enameling bath boilers. R. ALDINGER. *Keram. Rund-*

schau, **44** [10] 111–13; [11] 141–42 (1936).—Sheet-iron of reasonable thickness, about 1 mm., is essential to avoid deformation. Only electrical or autogenic soldering is tolerated. Heating tests at 800 to 900°C for 4 to 5 min. should be made. Compositions for ground and cover coats having a long temperature interval and shock resistance are given. Milling and enameling conditions are indicated. F.E.V.

Firing enamel on castings in the electric furnace. ERNST SCHMIDT. *Elektrowärme*, **6** [9] 267–69 (1936).—Enameling methods, fluxes, and temperatures best applied are briefly discussed, and a few furnaces are described. M.H.

Frameless steel building erected to house unattended telephone exchange. ANON. *Steel*, **97** [Sept. 16] 38 (1935).—A frameless 10- x 16-ft. steel building, with outer walls of porcelain enameled steel, is described and illustrated. H.E.S.

Hair cracks in enamel for cast iron. H. LANG. *Glashütte*, **66** [35] 602–606 (1936).—Hair cracks have their origin in the difference in the expansion of the iron and the enamel. Cases from practice are discussed. Methods of application which generally prevent the appearance of cracks are as follows: (1) Cast iron is sandblasted, and a wet coating of the frit ground and the majolica enamel is applied as powder on the fired fritted ground in one operation. (2) The same method can be used with acid-pickled cast iron. (3) This method includes fritted ground applied wet on sandblasted cast iron, firing of the ground coat, wet application of a white intermediate coat, and majolica powdered in one operation. (4) The same method is used except that the white intermediate layer is powdered. (5) A wet coating of the so-called "light" ground enamel is used on sandblasted cast iron with a direct powdering of majolica or opaque enamel on the fired ground. (6) Wet application of a dark ground is made on which an intermediate coat is powdered; majolica enamel is directly powdered on the latter or an opaque enamel is directly applied on the dark ground. The fifth method proved to be the best; a durable and resistant enamel is obtained. M.V.C.

Hardness tester for baked cores and sand molds. HARRY W. DIETERT CO. *Instruments*, **9** [10] 269 (1936).—This instrument weighs 12 oz. and is 3 in. long and $^3/_4$ in. thick. Surface hardness of cores and dried sand molds may be determined in a few seconds by pressing the instrument against the surface to be tested and drawing it along this surface. This gives a quantitative measurement of penetration hardness, since the dial measures the force along the axis of the diamond cone-tipped spindle. A table of standard (foundry) readings is supplied. R.W.R.

Leadless batches for cast-iron ware. VIELHABER. *Emailwaren-Ind.*, **13** [34] 278–79 (1936).—The composition of leadless enamels as suggested by P. Bull at the beginning of this century is discussed. M.V.C.

Leadless cast-iron ground enamel. VIELHABER. *Emailwaren-Ind.*, **13** [35] 286–87 (1936).—The development of the production of majolica enamel and light ground enamel without lead is given. A part of the lead oxide is replaced by boric acid, and some barium carbonate and cryolite are introduced. In cast-iron ground enamels, zinc oxide and calcite are added. A table showing the composition of such enamels is given. M.V.C.

Lime, strontium, barium, and magnesium in enamels. VIELHABER. *Emailwaren-Ind.*, **13** [35] 285–86 (1936).—Calcium is usually added in the form of calcite or fluorspar; and lime as calcite, marble, chalk, etc. Lime (CaO) increases thermal expansion; up to a certain amount it is a flux exactly as fluorspar, but above this amount this effect disappears. Magnesium is used as an addition to the mill to regulate viscosity. Mg is fused for special enamels; it lowers expansion, is refractory, affects refraction of light of the enamel, and increases the effect of opacifiers. Barium, a flux, increases luster and does not increase expansion markedly. It is used to replace lead oxide or minium in enamel. Strontium is used as a flux in the manufacture of majolica enamel. M.V.C.

Makes cooking easy. ANON. *Amer. Enameler*, **9** [5] 4 (1936).—Glenwood's new porcelain enameling plant is illustrated. J.H.S.

Mechanics of color matching. P. B. SMITH. *Amer. Enameler*, **9** [1] 3 (1936).—The general principles of color matching are described, from the equipment necessary for color matching to the careful control of spraying and firing of the sample plates. J.H.S.

Metallography in the service of technique. HUGO BECKER. *Emailwaren-Ind.*, **13** [36] 291–93 (1936).—The use of metallography for the study of the inner structure of materials, such as the separate formations in structure, chemical and physical properties of the material, and changes in the type and arrangement of the structure formations produced by different treatment of the material (heating, chilling, shaping, oxidation, absorption of gases, chemical attack, carbonizing, etc.), is discussed in detail. M.V.C.

Neatness and efficiency. ANON. *Amer. Enameler*, **9** [3] 3 (1936).—A detailed description of the plant and operations of the Roberts & Mander Stove Co., manufacturers of Quality ranges, is given. J.H.S.

Pickling sheet iron prior to porcelain enameling. J. T. IRWIN. *Metal Cleaning & Finishing*, **8** [10] 693–96 (1936).—Pickling of sheet iron prior to porcelain enameling involves considerations not connected with pickling prior to other finishing operations. Among these is the production of a uniform etch. I. discusses acid annealing and pickling, electric pickling, electric pickling using alternating current, rinsing and neutralizing, uniformity of etch, and inhibitors. E.J.V.

Preparing clay for porcelain enameling. H. C. GOUDY AND G. H. SPENCER-STRONG. *Amer. Enameler*, **9** [4] 3 (1936).—The preparation of clay and the testing of comparative suspending powers of clay are described in detail. J.H.S.

Rubber-lined equipment finds extensive use in modern pickling rooms. J. R. HOOVER. *Metal Cleaning & Finishing*, **8** [10] 687–92 (1936).—The applications of rubber-lined equipment in continuous, batch, and electrolytic pickling, as well as in ventilating and acid disposal systems for the pickling room, are described. Welded steel tanks, lined inside with $^1/_4$ in. of a special three-ply rubber known as Triflex and sheathed over the rubber with 8 in. of acid-proof brick, have proved highly successful as the latest development in acid handling installations. E.J.V.

Sand testing and its application in the foundry. H. W.

DIETERT. *Iron Age*, **138** [5] 24–25 (1936).—D. points out the necessity for control of sand and indicates the influence of sand characteristics on the physical properties of castings. For best results, the foundryman must carefully balance refractoriness, porosity, grain size, strength, and binder of sand. E.H.McC.

Seasholtz family of Reading. ANON. *Amer. Enameler*, **9** [5] 5 (Sept., 1936).—A history of J. M. Seasholtz & Sons, Inc., is given. J.H.S.

Shell type porcelain enameled refrigerator. F. L. MEACHAM AND E. F. SWELLER. *Amer. Enameler*, **9** [5] 16 (1936).—The shell type cabinet solved many production problems for the refrigeration industry but raised others. The authors tell how the problems have been met. J.H.S.

Sioglur. VIELHABER. *Emailwaren-Ind.*, **13** [16] 138–41 (1936).—The replacement of borax in the enamel by Sioglur, which is a fused silicate containing boric acid, alkalis, and silica, is discussed. About half of the borax usually used can be saved without lowering the properties of the enamel. M.V.C.

Sold. ANON. *Amer. Enameler*, **9** [5] 10 (1936).—Inside and outside porcelain enamel adds beauty to residential as well as commercial and industrial buildings. Illustrated. J.H.S.

Spraying apparatus for vitreous enameling. J. D. WHITEMAN. *Sheet Metal Ind.*, **10** [107] 243–46 (1936).—Some new developments in connection with spray equipment for vitreous enameling are described, and a few aspects of the selection, operation, and care of spray equipment are dealt with. W. enumerates the qualities of a good spray gun for vitreous enamel. A.P.S.

Standardization of tests of anti-acidic enamels. H. HECHT AND W. HORNER. *Keram. Rundschau*, **44** [9] 99–100 (1936).—A new process for the determination of anti-acidic resistance is described. The principle is loss of weight but the difficulties of usual processes are eliminated. Hollow cylindrical test pieces are enameled, edge defects being avoided. The surface is larger for a given weight of enamel and accuracy is increased. Operation in a steam-free room is possible; 15% lactic acid is proposed. Its effect is comparable with 10% formic acid but lactic acid has the advantage of nonvolatility. F.E.V.

Vitreous enameling practice in America. I. N. WHITESMITH. *Sheet Metal Ind.*, **10** [108] 319–21; [109] 391–92, 401 (1936).—W. describes the salient features and the general tendencies of modern American steel sheet enameling factories, paying particular attention to frit milling, metal preparation and design for enameling, frit control, dipping, special finishes, edge brushing, spraying and firing in box type or continuous muffles, matching and marking, and deënameling. A.P.S.

Westinghouse production flexible at Mansfield plant. ANON. *Amer. Enameler*, **9** [4] 5 (1936).—When Westinghouse purchased the Mansfield Vitreous Enameling Co. plant last year, the entire equipment was rearranged to provide facilities for materials to travel progressively through the enameling process with a minimum of handling. J.H.S.

Wooden pickling tanks. P. W. BENNINGTON. *Steel*, **97** [Dec. 2] 30–34 (1935).—B. gives some practical considerations involved in the design, construction, and maintenance of wooden pickling tanks. H.E.S.

BULLETINS

Durability of molding sands. C. H. CASBERG AND C. E. SCHUBERT. *Univ. of Ill. Bull.*, **33** [34] 52 pp. (1936).—The authors review tests applied to determine durability of molding sands and describe new experiments to outline a short and accurate method for this purpose and to obtain the necessary amount of bond or sand required to bring a used sand back to its original strength. Green strength and permeability of natural and synthetic sands are shown in curves. Formulas were derived to show the relation between base-exchange capacity of sand and bentonite and bonding substance. The life of a molding sand can not accurately be predicted. It is more economical for foundrymen to add clay or bonding substance to molding sands after using the sands for a number of heats than to try to hold the strength constant by frequent additions of bonding substance. The amount of bonding substance required to bring a given quantity of molding sand back to its original green compression strength depends entirely on the nature of the bonding material used. The durability of a molding sand depends on the physical and chemical properties of the minerals found in the bonding substance. 13 references. M.H.

Steel and glass incorporated. ANON. *Ind. Bull. Arthur D. Little, Inc.*, No. 78 (June, 1933).—The remarkable growth occurring in the porcelain enamel industry has resulted from developments in the application of glass-like surfaces to metals by fusing a form of glass on the metal base. The wide variety of products made from this material is discussed, including its recent use as an exterior facing for buildings. H.E.S.

PATENTS

Composition and method of setting up vitreous enamel slips. C. J. KINZIE (Titanium Alloy Mfg. Co.). U. S. 2,057,958, Oct. 20, 1936 (July 6, 1931). A setting-up composition for enamel slips for acid-resisting vitreous enamels on metals comprises acid-resisting glass mill liquor, gelatinous titanium hydroxide in flocculent form ($Ti(OH)_4$), not more than 4% clay, and an adhesive.

Vitreous enamel dispersions. R. S. BLEY (Porcelain Enamel & Mfg. Co.). U. S. 2,058,209, Oct. 20, 1936 (Dec. 31, 1935). A dispersion comprises a finely divided vitreous enamel frit and a liquid organic cobalt compound, the compound being anhydrous and stable at ordinary room temperatures.

Glass

Adsorption of organic substances on crystal surfaces: IV, Adsorption of sodium oleate and sodium nonylate on cinnabar. N. A. Held and I. A. Khainsky. *Kolloid-Z.*, **76** [1] 26–33 (1936).—The applicability of glass electrodes to the potentiometric titration of alkaline soap and fatty acid solutions is demonstrated, and the validity of Langmuir's equation for the adsorption isotherm is established. With water solutions of alkali soaps a 2-mol. adsorbed layer was formed on cinnabar surfaces. Also it was found that 2-mol. thick adsorbed layers formed on kaolin particles when the latter were brought into contact with sodium oleate. F.P.P.

Alteration of free surface energy of solids: I, Vertical-rod method for measurement of contact angles and preliminary study of effect of heat treatment on magnitude of contact angles. F. E. Bartell, J. L. Culbertson, and M. A. Miller. *Jour. Phys. Chem.*, **40** [7] 881–88 (1936).—The vertical-rod method is developed for the measurement of contact and interfacial contact angles against either transparent or opaque solids. The method gives accurate information concerning free surface energy changes. The solids studied were Pyrex brand glass, silica glass, gold, and platinum. Heat treatment of solids can greatly change the magnitude of the contact angle. The presence of strains in glass accounts for large water-air contact angles; these reduce to zero upon careful annealing. C.J.P.

Cement for glass. Kindscher. *Diamant*, **58** [26] 302–303 (1936).—Cements for cementing glass panes and ware are discussed. M.V.C.

Comparison of the glass and quinhydrone electrodes for measuring the activity of the hydrogen ion in sucrose solutions. H. P. Cady and J. D. Ingle. *Jour. Phys. Chem.*, **40** [6] 837–43 (1936).—The glass electrode gives reproducible results when used to measure the activity of the hydrogen ion in inverting sucrose solutions, whereas the quinhydrone electrode gives a gradually changing potential over long periods of time. C.J.P.

Compressibility of rocks and glasses at high temperatures and pressures; seismological application. Francis Birch and Richard B. Dow. *Bull. Geol. Soc. Amer.*, **47** [8] 1235–56 (1936).—Compressibility has been measured to a pressure of 10,000 kg./cm.^{2}, combined with temperatures of 0° to 300° or 400°C, for six artificial glasses, crystalline Solenhofen limestone, and an olivine diabase. The compressibility of these materials, except that of silica glass, increased with the temperature above 200°C. The procedure was described in *ibid.*, **46**, 1219–50 (1935). A.C.B.

Constitution of lead oxide-silica glasses: I, Atomic arrangement. II, Correlation of physical properties with atomic arrangement. George J. Bair. *Jour. Amer. Ceram. Soc.*, **19** [12] 339–58 (1936).

Cooling a 200-in. telescope disk. G. V. McCauley. *Elec. World*, **106** [27] 2058–61, 2107 (1936).—McC. deals with electrical control in annealing glass. E.H.McC.

Course in glassmaking. D. R. *Verre & Silicates Ind.*, **7** [16] 190–91; [20] 239–41 (1936).—The Cottrell-Lurgi-Möller system of electric refining of gas is described. The principal factors which govern the heating of industrial furnaces are considered. See *Ceram. Abs.*, **15** [8] 232 (1936). M.V.C.

Crickx, a master-glazier. J. Laenen. *Clarté*, **8** [2] 12–14 (1935).—Considerations are given on artistic church windows made by Frans Crickx. Illustrated. R.W.D.

Determining the expansion coefficient of glass by the sag of a double thread. B. V. Rabinovich. *Zavodskaya Lab.*, **5** [5] 624–29 (1936).—A thread of 200 mm. is formed by soldering together a rod of the glass investigated with one of another glass taken for comparison. In the case of a difference of expansion coefficients, the thread bends when heated to an arc with the height, h. The general relation between the expansion coefficients, $\Delta\alpha$, of the glass investigated and that taken for comparison, the thickness of threads, d, and the height of the arc, h, has been determined by the equation $\Delta\alpha - \Delta\alpha_0 = K(d - do)(h - ho)$. The graphical expression of the dependence of h on $\Delta\alpha$ for different values of d serves for determining numerical values of $\Delta\alpha$ and d, provided that the expansion coefficient of the comparison glass has been previously determined. P.B. & E.S.

Determining viscosity of quartz glass within the softening range. M. P. Volarovich and A. A. Leontieva. *Jour. Soc. Glass Tech.*, **20** [79] 139–43 (1936).—Using the elongating rod method, the viscosity of two specimens of quartz glass was determined in the softening range from 1100° to 1450°. The viscosity varied from 5.10^{13} to 9.10^{11} poises. The change in direction of the temperature-log viscosity curves was observed at about $10^{12.5}$ to 10^{13} poises, corresponding to a lower limit of the softening range, Tg, of 1220° to 1240°. Samples of silica glass from different sources gave slightly different results on account of the varying amounts of impurities present. A.A.

Development of glass decoration. K. Herain. Presented at Congress of the German Glass Manufacturers Assn., Berlin, Jan., 1936. Abstracted in *Sklarske Rozhledy*, **13** [2] 19 (1936).—Czech artistic glass production in the reign of King Rudolf II is described. R.B.

Effect of illumination conditions and camera position on photographs of cut glassware. Florence M. Anthony and Bertha Ginsburg. *Jour. Soc. Glass Tech.*, **20** [79] 119–22 (1936).—The effect of mode of lighting, camera position, and the reflection factor of the background screen was studied on the photographs obtained of a cut glass jug. Different conditions stressed different features. Completely diffuse illumination was used to avoid specular reflection from the cut surfaces. Some photographs were taken with a small amount of direct light in addition to the uniform illumination obtained with diffuse lighting. A.A.

"Etching figures" of glass. Tz. Vaĭnstein, B. Markin, and R. Müller. *Zhur. Fiz. Khim.*, **7** [3] 402–404 (1936).—In boron glasses primary cavities appear when polished. They form cuplike cavities in all cases where liquid glass touches a hard surface. The honeycomb character of etching figures takes place only in the case of an equal dissolution of the whole surface of the glass independently of its outer shape. P.B. & E.S.

Exhibition of mirrors. P. Prist. *Clarté*, **8** [1] 21–24 (1935).—Modern and ancient mirrors (from the 17th and

18th Centuries) were displayed in such a manner as to emphasize the evolution of these decorative articles. R.W.D.

Extract from the yearly report of the Czechoslovakian Technical Assn. of the Glass Industry (1935). ANON. *Allgem. Glas- & Keram. Ind.*, **27** [1] 2–3 (1936).—Because of the trade depression, only a few glassworks decided to improve or to rebuild their melting furnaces during the past year, although a certain number of factories (of small or of medium importance) still operate inefficient furnaces. Experiments were carried out on a tar cracking process. A summary of the results obtained with a new type of recuperative pot furnace designed by Knoblauch is given. R.W.D.

Fluorescence test: some recent developments. D. A. JONES. *Glass*, **13** [7] 298 (1936).—J. describes the Hanovia-Muir analytic lamp which supplies the ultra-violet rays necessary for the fluorescence test used in identifying and listing glasses. This is an improved mercury-vapor arc lamp which operates on a.c., gives 15% greater output, and requires 43% less current than the older type lamps. This gives an aggregate efficiency increase of 90%. M.C.S.

Flux-line protection for tank furnaces. O. ARENDT. Translated in *Glass*, **13** [5] 201 (1936); for abstract see "Protection—" *Ceram. Abs.*, **15** [11] 331 (1936). M.C.S.

Gas producers for glassworks. J. VERNET. *Arts & Métiers*, No. 189, pp. 134–36 (1936). R.W.D.

German glass mosaic. FRITZ HANSEN. *Diamant*, **58** [14] 157–58 (1936).—A historical review of German mosaic and its manufacture is given. Illustrated. M.V.C.

German standard specifications in glass technique. P. GLAZER. *Glashütte*, **66** [37] 631–34 (1934).—The development of standardization in Germany and the types of glassware standardized are described. M.V.C.

Glass bottle manufacture. UNITED GLASS BOTTLE MANUFACTURERS, LTD. *Elec. Rev.*, **119** [3067] 299–300 (1936).—A general description of the Charlton plant and its electric power is given. Illustrated. J.L.G.

Glass cement for special purposes. W. H. D. *Diamant*, **58** [10] 111–12 (1936).—The composition of cements used for attaching glass to wood, glass to glass, metallic plates to glass, etc., is given. M.V.C.

Glass etching. W. H. D. *Diamant*, **58** [12] 134–35 (1936).—The composition of various etching solutions and German patents dealing with etching are briefly discussed. M.V.C.

Glass etching. A. GLORY. *Nature* [Paris], No. 1, pp. 260–64 (1936).—The paper is devoted to the acid-etching and sandblasting of glass. R.W.D.

Glass etching. OTTO HERFURTH. *Diamant*, **58** [15] 171–72; [16] 181–82; [17] 194–95; [18] 206–207; [19] 218–19; [23] 267–68; [24] 280–81; [25] 291; [27] 313–14 (1936).—The two most important factors for obtaining good results when etching glass are (1) knowledge of the composition of the glass and the etching bath and (2) knowledge of the chemicals composing the bath. Methods of etching, composition, and the effect of various preparations on glass are discussed in detail. M.V.C.

Glass halts solar heat. ANON. *Arch. Rec.*, **80** [3] 239 (1936).—Solex, a glass developed by Pittsburgh Plate Glass Co., acts as a filter for barring or transmitting particular wave-lengths, absorbing a large proportion of the heat in sunlight. It transmits 75% of visible light and 28% of solar infra-red, and absorbs 56% of total solar energy. Looked at edgewise it is dark blue-green, but glazed into a window it is hardly distinguishable from other plate glass. E.B.H.

Glass thermolux. JAR. POLÍVKA. *Tchéco Verre*, **3** [3–4] 82–86 (1936).—An insulating glass which, at the same time, refracts and diffuses the rays of light irregularly is described. The fundamental principle is the placing of a glass spun tissue between two glass plates. This tissue consists of fibers 0.006 to 0.002 mm. thick, *i.e.*, of $^1/_7$ to $^1/_3$ the thickness of the human hair. Therefore 1 sq. m. of this tissue, in the layer of 1 to 3 mm. thick, contains about 1 to 3 million m. of fiber. These take only about 1% of space whereas 99% remains for air insulation. Light is diffused both in depth and width. See "Insulating—" *Ceram. Abs.*, **14** [7] 160 (1935). R.B.

Glass wool. M. K. *Diamant*, **58** [10] 112 (1936).—The use of glass wool as a filter to purify air is briefly discussed. M.V.C.

Glues and cements for the glass industry. OTTO HERFURTH. *Diamant*, **58** [2] 18; [3] 30 (1936).—The composition of various kinds of glues and cements used is briefly discussed. M.V.C.

Improvement of glass: I–II. OTTO HERFURTH. *Diamant*, **58** [4] 39–41; [10] 109–10 (1936).—Grinding glassware and the apparatus used are dealt with. M.V.C.

Investigating electrical conductivity of glasslike barium borates. B. MARKIN AND R. MÜLLER. *Zhur. Fiz. Khim.*, **7**, 592–98 (1936).—Electrical conductivities of the glasslike systems $BaO + B_2O_3$, $Na_2O + BaO + B_2O_3$, and $ZnO + B_2O_3$ were determined. The data obtained show that there is a movement of bivalent cations in glasses with a considerable content of the respective metallic oxide. The energy of tearing out the ion, $E \cong 2AR$, in barium and zinc glasses is two times higher than the energy (E) of alkaline boric glasses. The coefficient (B) has a normal value. A growth of the coefficient (A) of alkaline glasses is a result of the introduction of barium in these glasses. P.B. & E.S.

Investigation of the velocity of solution of alkaline boron glasses. TZ. B. VAÏNSTEIN AND R. L. MÜLLER. *Zhur. Fiz. Khim.*, **7** [3] 364–87 (1936).—The decrease of velocity of solution with the beginning of the growth of molar conductivity at equal concentrations of alkalis is not constant. The abrupt change of velocity of solution in the interval of concentrations $0 \leq 9 < 0.5$ corresponds to a fundamental change of the physical nature of the velocity of solution. The data obtained contradict the suggestion that, when quickly stirring, $\gamma \cong 1800$ in the interval $0 < 9 \leq 0.1$, that the diffusion layer is being quickly removed, and that the process is determined by the reaction. The data obtained when dissolving glasses of an intermediary composition with $q = 0.25$ under strong stirring give evidence of the presence of a displacement of the superficial layer of solid phase particles in these glasses. It is concluded that the solution of boron glasses in water to $q \cong 0.5$ has undoubtedly a nondiffusion character. Their velocity of solution is characterized by a total absence of the dependence on the velocity of mixing (probably with the exception

of potassium glass with $q = 0.98$) and by a high temperature coefficient, about 7 to 8% / 1°. The coefficients A and C in the formula $Vm = Ce^{-A/T}$ are equal to 5500 to 7500° and 0.4 to 400, respectively (mean value: $A = 6500 + 500$ and $C = 75 + 50$). P.B. & E.S.

Invisible lenses. T. E. OBRIG. *Sci. Amer.*, **155**, 258 (1936).—The manufacture of contact eye lenses has recently been perfected and over 3000 people in the U.S. are now wearing them. They are invisible and practically unbreakable. They can be worn where spectacles can not, and they neither steam nor form reflections. W.D.F.

Kinetics of solution of alkaline boron glasses. R. L. MÜLLER. *Zhur. Fiz. Khim.*, **7** [3] 388–401 (1936).—Former investigations of velocities of solubility demonstrate an almost complete absence of data on kinetics of interaction of the solvent with the dissolved matter, especially as to glasslike materials. A supplementary analysis of experimental data on the velocities of solution of boron glasses confirms a previous conclusion as to the undiffusive solution of glasslike borates of alkalis with a molar ratio $1 \geq 0.5$. A comparison of the value of the coefficient, C, calculated on the grounds of experimental data in the solution velocity formula $Vm = Ce^{-A/T}$ with the theoretically calculated coefficient leads to the conclusion that the Miyamoto theory based on the kinetic theory of gases can not be applied. The calculations of the constant, C, in accordance with the Frenkel adsorption theory and to some extent with the Polanyi and Wiegner theory of sublimation lead to more satisfactory results. An attempt is made to explain the series of solution velocities established experimentally for glasslike borates of alkaline metals. P.B. & E.S.

Laboratory glasses. BERNARD LONG. *Document. Sci.*, **5** [42] 49–54 (1936); abstracted in *Verre & Silicates Ind.*, **7** [18] 214 (1936).—The sensitivity which different glasses present to radiations of a different nature can be utilized to obtain superb iridescence by the addition of rare earths such as praseodymium and neodymium. According to the absorption power of the glass at certain wave-lengths, the tint of the coloration of the glass obtained with ordinary chromogenic agents can be modified. M.V.C.

Largest piece of glass in the world. A. GRADENWITZ. *Nature* [Paris], No. 1, pp. 65–69 (1935).—Essential details are given of the several steps in casting the 200-inch telescope disk. R.W.D.

Liberation of gas from vitrifiable mixes containing both sulfate and sodium carbonate. H. JEBSEN-MARWEDEL. *Sprechsaal*, **69** [32] 460–62; [33] 473–75; [34] 488–90 (1936); *Verre & Silicates Ind.*, **7** [19] 221–28 (1936).—The behavior of carbonates and sulfates entering into the composition of a glass during the state of reaction was observed. The conditions of work recommended by practice are justified, and decomposition of sulfate follows soon after the beginning of the carbonate decomposition. The experiments gave the following conclusions: (1) The mass of the composition in relation to the free surface, the partial pressure of the atmosphere above the composition, and the entire mass, because of its thermal sluggishness, have a great influence on the rate of disintegration of the composition. (2) The study of the phenomena of fusion between 900 and 1300° gives an indication which holds good for higher temperatures. (3) The liberation of SO_3, compared with the liberation of the carbonate, occurs slowly but increases rapidly with an augmentation of the concentration of sulfate in the mix, owing to the augmentation of the surface of reaction. (4) In contrast to carbonic acid, the liberation of SO_3 does not reach the theoretical value but only the known residue of 1%, independently of the quantity of sulfate originally contained in the composition. (5) Small quantities of sulfate without carbon or large quantities of sulfate with carbon have the same effect as to time in the development of the fusion, which corresponds to conditions recommended in practice. (6) With the addition of carbon, especially at low temperatures, only the first part of the liberation of SO_3 is accelerated, while the remainder disintegrates slowly. This is due to the fact that carbon is partially consumed at low temperatures without effect before attacking the sulfate, while at high temperatures a thermal disintegration of sulfate contributes toward making the transformation complete and more effective. M.V.C.

Manufacturing mirrors with cellular reinforcements for astronomical instruments. N. G. PONOMAREV. *Z. Instrumentenk.*, **56** [9] 379–84 (1936).—The difficulties of producing massive glass disks for reflector mirrors and their defects for astronomical purposes are discussed. Methods are described for casting such disks in steel forms so that the glass does not stick to the form and for reinforcing the disks by providing honey-combed ribs, either casting the latter directly with the glass disk or separately and then welding them on later. A few examples are described. M.H.

Methods of mirror coating. W. H. D. *Diamant*, **58** [17] 198 (1936).—The composition of solutions used for the manufacture of mirrors is given. M.V.C.

Milk glass manufacture. W. H. D. *Diamant*, **58** [11] 123 (1936).—The manufacture of opaque glass of various colors and the use of opacifiers are briefly discussed. M.V.C.

Mirror production method. ANON. *Amer. Glass Rev.*, **55** [47] 19 (1936).—With the development of an ingenious conveyer system a semi-automatic method of silvering mirrors has resulted. This is the first major improvement in the production of silvered mirrors in thirty years. Production has been increased 60% with a decrease in working force of 50%. M.C.S.

Opacification of cooled glassware on reheating. G. BULLA AND A. DIETZEL. *Sprechsaal*, **69** [25] 358–59 (1936).—On reheating ordinary alkali-lime glass to softening temperature or over, it became opaque. This opacification consists of a surface devitrification which becomes visible to the naked eye because of the great number of crystals formed. These formations are probably due to the liberation of silica by alkaline sulfates and bisulfates formed by sulfurous acids. This phenomenon takes place in Na-Ca glasses rich in alkalis with 16 to 18% alkali and more than 74% SiO_2 (in which silica precipitates on devitrification) but not in glasses rich in alkalis with less than 74% SiO_2 (devitrite is the devitrification product). In acid Na-Ca glasses, the attack of cooling gases within the normal technical time is too weak to produce a marked effect. M.V.C.

Pb_2GeO_4 glass and the corresponding silicate, Pb_2SiO_4. W. SCHÜTZ. *Sprechsaal*, **69** [19] 270–71 (1936).—Pb_2GeO_4

solidifies in a vitrified state from the melt, while Pb_2SiO_4 is obtained in the crystalline state only. Attempts are made to interpret quantitatively the crystal-chemical reactions taking place. M.V.C.

Permanent anisotropy of window glass. P. GAUBERT. *Bull. Soc. Franç. Minéral.*, **58** [5-6] 314-22 (1935).—Sheets of window glass which are more or less birefringent may show the following optical characteristics: (1) The plates are homogeneous and equivalent to a crystalline, optically negative plate with the optic axis normal to the plate. (2) The birefringence varies regularly from one edge of the plate to the other, the plate being composed of two or more layers of different optical sign. (3) Window glass is often composed of a number of birefringent layers which are strictly parallel, the cross-section of the sheet when examined between crossed nicols having the appearance of polysynthetic twins. Some bands are optically negative and others optically positive. There is no regular repetition of these bands and their size is variable. The layers have the same characteristics over a large area of the sheet so that it is possible by optical examination of the edge of a small piece to identify the sheet from which it comes. H.I.

Photochemical changes of manganese glasses. JOSEF HOFFMANN. *Sprechsaal*, **69** [37] 534-36 (1936).—The results of exposure of glasses containing manganese to beta and gamma rays of 610 mg. radium or "ionic pipe" with copper anode (15 ma. and 40 kv.) are described: (1) The general sensitivity to light of Mn glasses from the visible blue-violet to the smallest invisible waves of light is directly due to the position of the manganese atom in the system of elements and to the valence-unsaturated form of manganic oxide molecules which are intercalated in the atomic netlike spaces of Mn silicate glasses. (2) Various glass compositions, methods of melting glasses, and changes in glass coloring and their causes are described. Yellowish manganous glasses were obtained only when the manganous form was introduced into the glass composition and melted in a reducing atmosphere; these glasses are sensitive to light and when exposed change their coloring twice to red and finally to blue. (3) The different coloring of manganous glasses melted in an oxidizing atmosphere and of normally melted pyrolusite glasses shows that the process of the MnO_2 decomposition in the glass is not similar to the oxidation process of MnO decomposition. (4) Manganous compounds which are not imbedded are generally resistant when exposed. (5) The yellow-colored iron-manganese chains were shown to be generally stable on exposure; red coloring after exposure is due to Mn_2O_3 ions, while the blue is due to Mn_3O_4 ions. (6) The violet coloring of white glasses covered with Mn is a result of a chemical luminous process: (*a*) the decomposition of yellow ferric oxide ions to blue ferrous ions, the result of exposure to visible blue-violet and invisible rays (UV-, beta-gamma, X-rays); and (*b*) oxidation of manganous oxide molecules into higher forms, Mn_2O_3 to red or Mn_3O_4 to blue. (7) The oxidation of manganous oxide molecules present in the atoms of the glasses is caused by oxygen of three origins: (*a*) oxygen present in spaces in the glass, (*b*) processes of coloring of the surface by oxygen from the air, and (*c*) oxygen liberated in the glass mass when exposing Fe (3)-oxide forms and their decomposition into Fe(2)-oxide. (8) The coloring of Mn-coated white glasses is weaker when exposed in air without O than that of those exposed in ordinary air; it is assumed that oxygen necessary for oxidation is taken from the glass mass. (9) There is no difference in the weight of glasses before and after exposure in a vacuum. (10) Originally white Mn glasses exposed in air show a different weight during and after exposure; the increase in weight was usually smaller when the exposed glasses were saturated (reached the deepest coloring) than during the exposure itself. (11) The rapid appearance of the red coloring, the longer exposure necessary to produce violet coloring, and the changes in weight during and after exposure show that the red coloring is produced by a process of oxidation while the violet coloring is produced by decomposition processes proceeding slowly. (12) The reactions occurring during exposure are (*a*) $2MnO + O = Mn_2O_3$ yielding red, an oxidation process; (*b*) $3Mn_2O_3$ (red) $- O = 2Mn_3O_4$ (blue), a decomposition process occurring before the color of saturation is reached. M.V.C.

Photographing glass for commercial purposes. C. WORMALD. *Jour. Soc. Glass Tech.*, **20** [79] 104-109 (1936).—The first and larger group of commercial photographs comprises photographs for record purposes. The second group includes those in which detail and exact reproduction are subsidiary to what might be called, in the case of glass, "the spirit of glass." In the production of illustrations, photographs having a light background are preferred to those having a dark background as they make better blocks, except in cases where design of cut glass must be shown. A.A.

Physical properties of lithium-beryllium borate glass, "Getan." S. HERTZRUCKEN. *Tech. Phys.* [U.S.S.R.], **3** [4] 336-49 (1936) (in German); abstracted in *Science Abs.*, **39** [465] 970 (1936).—A glass has been made which is transparent both to ultra-violet and to X-rays. The principles of its construction are explained, and the composition is proved by X-ray methods. H.K.R.

Pola screens and their applications to the photography of glassware. J. L. HOUGHTON. *Jour. Soc. Glass Tech.*, **20** [79] 123-26 (1936).—By use of the Pola screen an object can be illuminated with plane-polarized light. The construction, properties, and applications of the Pola screen are outlined. Such screens permit the high lights of a subject to be reduced, and their application to the photography of glassware is discussed. The screens transmit all the wave-lengths from 4000 Å to 7000 Å; the ultra-violet is strongly absorbed, and the infra-red is almost completely transmitted. A.A.

Presence of compounds in molten glass. ERIC PRESTON AND W. E. S. TURNER. *Jour. Soc. Glass Tech.*, **20** [79] 144-51 (1936).—In connection with the recent publication by Heidtkamp and Endell of the results of their determinations of the density and viscosity at high temperatures of the soda-silica glasses (*Ceram. Abs.*, **15** [9] 272 (1936)), the likelihood of changes of curvatures in the temperature-viscosity-composition curves and in the density-composition curves at different temperatures as being indicative of the presence of the compounds $Na_2O \cdot 2SiO_2$ and $Na_2O \cdot SiO_2$ is discussed. The evidence of the presence of compounds is also afforded by the study of glassmaking reactions, by the volatilization of alkali from a similar

series of glasses, and by the obvious chemical changes taking place in colored glasses. Without experimental proof, the existence of the compounds $Na_2O \cdot 2SiO_2$ and $Na_2O \cdot SiO_2$, which are known to be stable at their melting points, should not be denied in the liquid state. Elementary facts of chemical combination should be taken into account with any theory of the constitution of glasses.

A.A.

Production of iron and glass in "tapped gas" producers from blast-furnace slag and similar rocks. JULIUS LAMORT. *Stahl & Eisen*, **56** [36] 1006–1007 (1936).—Blast-furnace slag is used at present as a silicate raw material for glassmelting. Basalt is also an excellent raw material for bottle glass after the reduction of its iron; 100 kg. basalt yield 15 kg. raw iron and 80 kg. of bottle glass. Similar glass is produced from melted phonolite, Zittaues granite, and limestone. All volcanic rocks contain alkalis which are valuable ingredients and which are introduced into the glass melt. The production of silicates and iron (as a by-product) from basalt in a "tapped gas" producer in France is described. A brief discussion of the use of blast-furnace slag for the manufacture of glass is given. M.V.C.

Rare glass defects. RUDOLF LEHMANN. *Glashütte*, **66** [34] 567–68 (1936).—The origin of striae in blown glassware is discussed. It was found that the striae are due to drops of molten refractory from the crown which fall periodically into the molten glass. Illustrated.

M.V.C.

Review of the chemical industry: glass industry. A. TRAVERS. *Rev. Gén. Sci.*, **47** [2] 43–46 (1936).—Recent progress in the study of the physicochemical properties of glass and in the manufacture of high-grade refractory materials is dealt with. R.W.D.

Safety glass in motor vehicles. S. A. MADDOCKS. *Sydney Morning Herald*, Aug. 22, 1936.—British regulations effective Jan. 1, 1937, make compulsory the installation of safety glass in the windshields of motor vehicles. The question of enforcing a similar rule in Australia is under consideration, but it would be ineffective if sufficient supplies were not available by local manufacture or import. H.H.S.

Schwaller furnaces. F. S. *Verre & Silicates Ind.*, **7** [23] 275–77 (1936).—Pot furnaces of the Schwaller system are used to a great extent in France, Italy, and Spain. Details of construction and operation are given. M.V.C.

Separation sequence of silicates from fluid magma and their lattice energies. G. G. LAEMMLEIN. *Compt. Rend. Acad. Sci., U.R.S.S.*, No. 1, pp. 33–35 (1936).—The separation sequence of silicates from magma or their relative stability corresponds approximately to the normal row of silicates with a progressing complication of the silica or aluminosilicate skeleton. This complication leads to a relative decrease of the energy of the crystalline network which explains essentially the meaning of reaction relations in the Bowen row. These relations appear when determined temperature, pressure, and chemical composition conditions are observed. P.B. & E.S.

Six-curve lens. AMERICAN OPTICAL CO. *Steel*, **97** [Dec. 9] 60 (1935).—A new goggle lens known as the six-curve Super Armorplate will withstand a test of a 1-in. steel ball dropped from a height of 10 ft. (The standard test for goggle lenses specifies a $^5/_8$-in. steel ball dropped from a height of 39 in.) The 6-curve lens is more effective in deflecting glancing blows because of its higher curvature and permits a closer fitting to the face.

H.E.S.

Slag wool and its production. E. K. GAVRILOV. *Stroitel. Material.*, No. 4, pp. 44–48 (1936).—G. describes the production process at the Bilimbaevo plant.

P.B. & E.S.

Solubility characteristics of glasses basically different in composition. W. C. TAYLOR AND R. D. SMITH. *Jour. Amer. Ceram. Soc.*, **19** [11] 331–35 (1936).

Specific gravity of glass. IKUTARO SAWAI, MORIO NISHIDA, AND IKUZO KUBO. *9th Internat. Congress Pure and Applied Chem.*, **III**, 343–51 (1934); abstracted in *Chem. Zentr.*, **ii**, 2423 (1936). M.V.C.

Split-proof glass and accident prevention. L. TEISSL. *Zentr. Gewerbehyg. Unfallverhütung*, **22** [9] 136 (1935); abstracted in *Ibid.*, **23** [3–4] 84 (1936).—Split-proof glass for spectacles, to lessen eye-injuries, is useful in both near- and far-sight adjustments and for gas masks. An oculist advocates the so-called "combination glass" as best. This glass is used in large forms for power vehicles. He found Securit glass not up to standard in testing it, although it is advertised for such ocular purposes. In England, safety glass is required by law for all power-driven vehicles. K.R.

Spun or fiber glass useful in many ways. ANON. *Nat. Glass Budget*, **52** [17] 16 (1936).—Spun glass is being substituted for cotton, wool, linen, and silk fabrics in certain types of textiles. Such glass fabrics are much stronger than cotton fabrics and are also acid resistant, mothproof fireproof, and weatherproof. M.C.S.

Strength and physical properties of fine glass fibers and yarns. GAMES SLAYTER. *Jour. Amer. Ceram. Soc.*, **19** [11] 335–37 (1936).

Technical aspects of the photography of glass. A. E. J. VICKERS. *Jour. Soc. Glass Tech.*, **20** [79] 110–18 (1936).—The essential constitutional photographic difficulty is that the tone range of the subject spreads over practically the whole range capable of being recorded by a normal photographic plate. This allows no "latitude" and necessitates that the exposure be absolutely correct. The effect of angle of illumination and background is discussed with reference to eight subjects. Illustrated. A.A.

Thermal control in minimum-deviation refractometry and temperature coefficients for a medium flint glass. LEROY W. TILTON. *Jour. Research Nat. Bur. Stand.*, **17** [3] 389–400 (1936); R. P. 919. Price 5¢.—Constructional details are given for a constant-temperature housing for minimum-deviation measurements on a spectrometer, and the operational procedure is described. Provision is made for mounting and properly adjusting the prism in a temperature-controlled bath of stirred air contained in a water-jacketed cylinder provided with plane-parallel windows that are adjustable for use over a wide range of prism angles and refractive media. Typical temperature coefficients of refractivity are given for a medium flint glass. R.A.H.

Transformation in glass. NIUTA KLEIN. *Compt. Rend.*, **203** [2] 180–82 (1936).—Every glass exists in two allotropic varieties, (1) α, which is stable in the cold state,

and (2) β, which is stable in the hot state. The transformation from one to the other has been investigated by measuring the refractive index as a function of temperature. All these curves have asymptotes parallel to the abscissa (temperature) axis. M.H.

200-inch telescope develops. C. S. McDowell. *Sci. Amer.*, **155**, 252–57 (1936).—Five years were spent in studying sites, and the one chosen is Palomar Mountain. The mounting will be of the equatorial type. The moving parts will weigh 1,000,000 lb. and will be carried on oil pad bearings. The grinding of the main mirror and the auxiliaries will take about four years, and by that time the mounting should be ready. See *Ceram. Abs.*, **15** [7] 204 (1936). W.D.F.

Volatilization of sulfate from soda-lime-silica glasses. E. Preston, W. E. S. Turner, and H. Laithwaite. *Jour. Soc. Glass Tech.*, **20** [79] 127–38 (1936).—Four soda-lime-silica glasses were prepared containing SiO_2 74, CaO 10, and Na_2O 16%. SO_3 was introduced in varying amounts (0.31 to 0.83%) at the expense of SiO_2. Samples from the glasses were heated at temperatures from 1300° to 1450° in an oxidizing atmosphere. The loss of sulfate was found approximately proportional to the initial sulfate concentration. After 100 hours of heating at 1350°, 1400°, and 1450° the sulfate contents were reduced, respectively, to about $^3/_8$, $^1/_2$, and $^1/_3$ of their initial values. Loss due to total volatilization varied with temperature and obeyed a vapor-pressure law. Sulfate losses determined analytically, when compared with the total volatilization loss, showed that the presence of SO_3 caused an increase in the loss of alkali which approximated to twice the alkali volatilization experienced in a pure glass of the same composition containing no sulfate. A.A.

Wright is wrong. F. W. Preston. *Bull. Amer. Ceram. Soc.*, **15** [10] 373 (1936).

BOOKS AND BULLETINS

Glass. Anon. *Ind. Bull. Arthur D. Little, Inc.*, No. 75 (March, 1933).—When all the types of glass and their susceptibility to improvement are considered, it appears that glass is prime among the super-materials of construction. H.E.S.

Heating up of glass furnaces. H. Knoblauch. *Fachausschuss.-Ber.* (Deut. Glastech. Ges.), No. 4, 6 pp. (1926).—Drying without fire is the best. A concrete bed is necessary for protection against ground moisture, and cooling pipes should be used to prevent heating of the concrete. The lower parts of the furnaces should be insulated after the heating up is ended. At the start, temporary set-ups are used; the elimination of damp waste gas is essential. The temperature must increase continuously but there are critical zones where a slower increase is compulsory. Pots with 30 to 50% crude clay are suitable at 400 to 500°C. Well-fired Dinas blocks show cristobalite transformation at 100 to 300°C; their expansion up to 1400° should not exceed 2%. Very large blocks must be avoided. Waste gas should be evacuated before the introduction of fuel in the laboratory. The danger of local overheating and the character of the expansion joints and mortars are emphasized. The behavior of acidic and basic material is described. F.E.V.

Indian glass industry. E. Dixon. *Bull. Ind. Research Bur.*, Govt. of India. 39 pp. Price 14 As. or 1s 3d. The manufacturing costs of Indian glass are unnecessarily heavy, owing to excessive use of fuel and soda ash and to the wasteful class of furnaces employed. The additional expense so incurred has no justification as the resulting glass is of a poor quality. It is not surprising that the Indian glass industry has not thrived though there is immense scope for development in the country. Japan, Belgium, and other advanced manufacturing nations are increasing their exports of glass into India. A.P.Som

Life in an Old Glass Factory. J. Bárta. Published by the Archive for the History of Commerce, Industry, and Technical Work. 76 pp., 22 illustrations. B. discusses the following topics: (1) natural conditions for glass factories in Czechoslovakia, (2) master-smelter's work, (3) Bohemian glass furnace (kiln), (4) raw materials, (5) glass smelters' festivals, (6) glass blowers' customs, pronouncing the glass blower a master-blower, (7) "Vymetání," *i.e.*, accepting an outside master into the glass guild, (8) wandering glass smelters, tale-tellers, (9) old terminology, and (10) patriarchal life in glass factories. R.Barta

Production Capacity of Fourcault Machines. B. S. Shvetzov. NKTP, Moscow, 1936. 118 pp. Price 6 R. This book deals with a survey made of the Chernyatinsk glassworks to increase the output and quality of glass manufactured on Fourcault machines. M.V.Condoide

Technology of Defects in Glass Manufacture (Glastechnische Fabrikationsfehler). Hans Jebsen-Marwedel. Published by Julius Springer, Berlin, 1936 (with the support of the Deutsche Glastechnische Gesellschaft). x + 295 pp., 441 illustrations, and one colored plate. Price 45 Rm., bound 48.60 Rm. This volume is introduced by the Deutsche Glastechnische Ges. as a companion text to Glastechnische Tabellen, with which it conforms in typography and size. The author, well known for his research papers, has drawn upon his rich experience in the examination of glass and has been helped materially by the acknowledged contributions of others. The book is divided into nine chapters. References to the literature are accumulated at the end of each chapter, freeing the pages from footnotes and adding to the general appearance of the book.

The first chapter is a general discussion of defects, setting forth the importance of a study of these faults and how much they influence the profitable production of glassware. Statistical information is presented by means of diagrams and graphic charts. Some of the means of separating defective portions for examination are described. Use is made of the Morey and Bowen phase-rule diagram of the Na_2O–CaO–SiO_2 system, showing the fields of the isotherms, with the superposition of shaded areas indicating regions of minimum crystallization according to Zschimmer and Dietzel, regions of best durability according to Mylius and Keppeler, and lines of equal viscosity according to Washburn, Shelton, and Libman.

Defects are grouped, according to their source, into defects in the melt and defects in the production of ware. Under the first group appear chapters on glass in glass (cords), gases in glass (seeds), solid bodies in glass (stones and knots), crystals in glass (devitrification), and the color of glasses, with special reference to the effect of iron under

various conditions and to decolorizing. Defects arising in the maufactured product are considered under faulty shape, defective surfaces, and cracks and fissures.

The precise character of each type of defect has been given thorough analytical treatment. Each fault has been traced to its sources, and pains are taken with the logical demonstration of cause and effect. Illustrations are made from skiagraphs, photographs taken by light reflected at carefully chosen angles, photomicrographs, and from photomicrographs taken through the polarizing microscope as well as photographs taken by polarized light without magnification. Every device has been resorted to which can serve to make distinct, by exaggeration, the cord, stone, blister, crack, crystal, or other flaw which the most painstaking selector might find in an article of manufactured glass.

Cords, waves, streaks, and threads are discussed from the standpoint of lack of homogeneity, and careful distinctions are drawn between surface markings arising from temperature differences and the lack of homogeneity arising from incomplete mixing in batch or in fusion and the introduction of foreign material from external sources such as the refractories.

The chapter on gases covers the problem of plaining, or refining, and discusses thoroughly the evolution of gases such as CO_2 and SO_2 from reactions between raw materials. Much attention is paid to furnace atmosphere and secondary reactions between various gases. Schematic drawings are introduced showing how bubbles may originate from iron, refractories, or other foreign materials, and how these bubbles in their passage through the melt may give rise to other phenomena.

The conduct of tank blocks and their behavior as they are corroded and dissolved by the glass is treated in much detail. Little doubt is left as to the probable manner in which stones are released from the refractories and introduced into the glass. Similarly, the various phenomena of devitrification are given careful treatment. It is interesting to note that the name "Devitrite" has been adopted for the 1-3-6 silicate (see *Ceram. Abs.*, **10** [8] 604 (1931)). This chapter (V) has some especially fine photographs of crystals occurring as devitrification products.

It is evident from Chapter VI that the problem of decolorization and the maintenance of good color is more serious with the Germans, whose natural supply of raw materials seems scarcely comparable to that of the U. S. in freedom from iron. Nevertheless, this chapter will be found useful by any glassmaker puzzled by the apparently erratic behavior of this ubiquitous colorant.

The differences between German and American procedures in glassworking and the relative predominance of manual over mechanical operation, as compared with U. S. practice, make the chapter on defects in forming a trifle difficult to understand and to apply. Likewise, in the chapter on surface defects, a good deal of trouble is apparently borrowed which might be seldom encountered with the cleaner fuels which we possess. The final chapter deals with matters concerning breakage, cracking, and internal strain which are of universal application. The illustrations are particularly valuable and well selected.

The book is an impressive piece of work. It might be called a treatise on "Vitreous Pathology." The average technologist, with his mind ordinarily intent upon the economical production of clear and homogeneous glass, properly fabricated, might almost be depressed by finding in this volume so many different ways in which his product may become seriously defective. His experience will be like that of the healthy person who browses in the doctor's library and thereafter imagines that he possesses a number of rare diseases. But all this does not detract in any way from the achievement of the author in collating and organizing this material and in furnishing accurate diagnoses for almost countless varieties of poor glass. If "one picture is worth ten thousand words," this book, with its beautiful illustrations, is worth a whole library of textual discussion of defects in glass. We can not detect where any riding of hobbies is indulged in. All workers and writers who have in any way contributed to the problem have been given citation and report.

We congratulate the author upon this volume, which must represent the accumulation of years of study and compiling of data; we commend the Deutsche Glastechnische Gesellschaft for supporting the production of this splendid reference work, a second achievement, ranking with the Tabellen; and we congratulate the publishers upon the physical beauty of the book. S.R.SCHOLES

Tough glass. ANON. *Ind. Bull. Arthur D. Little, Inc.*, No. 95 (Nov., 1934); see *Ceram. Abs.*, **14** [3] 67 (1935). H.E.S.

We may wear glass. ANON. *Ind. Bull. Arthur D. Little, Inc.*, No. 90 (June, 1934).—The essential differences between glass wool, glass cotton, and glass silk are explained. In addition to their use as cloth and insulation, the industrial chemical field promises a wide use for filtration, contact reactions, and gas scrubbing. H.E.S.

PATENTS

Annealing leer. L. P. PIAZZOLI, JR. (Capstan Glass Co.). U. S. 2,056,207, Oct. 6, 1936 (April 21, 1930).

Apparatus for laminating glass. WILLIAM OWEN (Pittsburgh Plate Glass Co.). U. S. 2,054,864, Sept. 22, 1936 (Feb. 19, 1934).

Apparatus for tempering tubular glass articles. W. B. CLITHEROW (Pilkington Bros., Ltd.). U. S. 2,054,595, Sept. 15, 1936 (Nov. 4, 1935).

Apparatus for use in case hardening glass sheets. D. H. GOODWILLIE (Libbey-Owens-Ford Glass Co.). U. S. 2,057,569, Oct. 13, 1936 (July 16, 1934).

Bottle tiering apparatus. F. E. BAKER (Owens-Illinois Glass Co.). U. S. 2,058,397, Oct. 27, 1936 (March 13, 1935).

Building block and facing tile. RUDOLPH KALKUSCH. U. S. 2,058,235, Oct. 20, 1936 (March 13, 1936).

Combination annealing and decorating leer. W. A. MORTON (Amco, Inc.). U. S. 2,058,171, Oct. 20, 1936 (Feb. 14, 1934).

Cover glasses for signalling projectors, etc. CORNING GLASS WORKS. Brit. 453,813, Sept. 30, 1936 (Feb. 4, 1935).

Edge grinder for optical lenses. L. G. KRAEMER AND G. W. BURROUGHS (Gotham Optical Instrument and Machinery Corp.). U. S. 2,054,985, Sept. 22, 1936 (Nov. 19, 1934).

Edge grinding machine. J. P. CROWLEY (Libbey-

Owens-Ford Glass Co.), U. S. 2,056,168, Oct. 6, 1936 (June 6, 1934). T. G. WRIGHT (Duplate Corp.), U. S. 2,057,809, Oct. 20, 1936 (April 20, 1935).

Electric furnace for heating sheets of plate glass or sheet glass before tempering. RAYMOND MAGNIEN (Soc. Asurex le Roi des Verres de Securité Magnien, Monnier, et Cie). U. S. 2,055,981, Sept. 29, 1936 (Jan. 9, 1935).

Glass. LOUIS NAVIAS (General Electric Co.). U. S. 2,056,930, Oct. 6, 1936 (Aug. 11, 1934; May 24, 1935). A glass which is resistant to hot alkali metal vapor and containing barium oxide and other usual glass-forming constituents including alkali oxide, boric anhydride, and silica, is characterized by a content of barium oxide within the limits of about 25 to 50%, a content of boric anhydride within the limits of about 20 to 50%, and a content of silica less than about 20%.

Glass body forming machine. FELIX MEYER (Kimble Glass Co.). U. S. 2,058,812, Oct. 27, 1936 (Jan. 26, 1934).

Glass building unit. ANTOINETTE REISIG. U. S. 2,059,489, Nov. 3, 1936 (Oct. 28, 1935). A reversible structural unit for veneered walls is described.

Glass composition transparent to ultra-violet light. J. A. M. SMELT (General Electric Co.). U. S. 2,056,627, Oct. 6, 1936 (April 14, 1931). A glass for radiating ultra-violet light consists of substantially 65% SiO_2, 2% B_2O_3, 5.5% Na_2O, 9.5% K_2O, 15% BaO, 3% ZnO, iron in traces, and a quantity of fluoride in the ratio of 1 kg. of fluoride to 100 kg. of the glass mixture.

Glass feed control mechanism. S. G. STUCKEY (Obear-Nester Glass Co.). U. S. 2,055,711, Sept. 29, 1936 (June 7, 1933).

Glass feeder. W. A. MORTON. U. S. 2,059,889, Nov. 3, 1936 (June 28, 1930).

Glass feeding method and apparatus. A. H. STEWART (Phoenix Glass Co.). U. S. 2,055,676, Sept. 29, 1936 (Sept. 19, 1932).

Glass gathering device. A. C. PARKER (Libbey Glass Co.). U. S. 2,056,981, Oct. 13, 1936 (Aug. 27, 1931).

Glass grinding machine. K. A. WEBER. U. S. 2,057,174, Oct. 13, 1936 (Nov. 6, 1934).

Glass-to-metal seal. HOWARD SCOTT (Westinghouse Electric & Mfg. Co.). U. S. 2,057,452, Oct. 13, 1936 (Jan. 31, 1934).

Glass-molding machine. EWALD THEILER. U. S. 2,055,884, Sept. 29, 1936 (Jan. 23, 1935).

Glass-steel building construction. ISADORE FRIEDMAN. U. S. 2,059,332, Nov. 3, 1936 (Oct. 23, 1935). A building of the glass-steel type consists essentially of an outer glass wall and an interiorly arranged supporting framework, means associated with the framework for eliminating shadows cast by the latter on the outer wall when the building is illuminated from within, and means simultaneously constituting an ornamental inner lining for the building and increasing the heat insulation thereof.

Glassware spotter. C. B. OHRN (Hartford-Empire Co.). U. S. 2,059,177, Oct. 27, 1936 (May 1, 1933).

Glass wool and method of treating. R. C. WILLIAMS AND H. M. BONE. Brit. 453,096, Sept. 16, 1936 (Jan. 31, 1936).

Heat treatment of alloy glass machine castings. A. W. GREGG AND R. H. FRANK (Bonney-Floyd Co.). U. S. 2,057,892; Oct. 20, 1936 (July 31, 1933). The method of hardening chromium alloy glass machine castings consists in producing an alloy casting having substantially the following composition: carbon 0.80 to 1.0%, chromium 11.50 to 12.00%, nickel 3.40 to 3.75%, molybdenum 0.90 to 1.25%, silicon 0.90 to 1.35%, titanium 0.40 to 0.55%, the remainder being substantially iron, the casting having a Brinell hardness of the order of 250 and being in austenitic condition as cast, machining the casting to desired shape, then subjecting the casting to an annealing heat cycle in which the casting is maintained at temperatures of the order of 1700° to 1750°F for a period of time varying between 1 to 4 hr., and then slowly cooling the casting while it is retained in the furnace zone whereby to increase the Brinell hardness thereof to the order of 500 to 550 and to homogenize it against subsequent heating cycles.

Laminated glass and process for making. J. F. WALSH (Arthur D. Little, Inc.). U. S. 2,054,108, Sept. 15, 1936 (Oct. 14, 1932). Laminated glass comprises sheets of glass united by zein plasticized with an aromatic-alkylated-sulfonamide.

Machine for edging glass sheets. WILLIAM OWEN (Pittsburgh Plate Glass Co.). U. S. 2,057,844, Oct. 20, 1936 (Jan. 11, 1936).

Machine for the manufacture of blown glass articles of large capacity. SOC. ANON. D'ETUDES ET DE CONSTRUCTIONS D'APPAREILS MÉCHANIQUES POUR LA VERRERIE. Brit. 452,910, Sept. 16, 1936 (April 18, 1935).

Manufacture of glass silk. W. U. DYKES (P. H. A. Mount). Brit. 452,810, Sept. 9, 1936 (May 3, 1935).

Method and apparatus for cutting wired glass. JOSEPH GASKELL (Pilkington Bros., Ltd.). U. S. 2,058,307, Oct. 20, 1936 (May 26, 1936).

Method and apparatus for feeding glass. A. J. BLACK (Harold M. Black). U. S. 2,058,763, Oct. 27, 1936 (March 5, 1935).

Method and apparatus for forming glass bodies. FELIX MEYER (Kimble Glass Co.). U. S. 2,059,474, Nov. 3, 1936 (Oct. 23, 1933).

Method of:

Affixing foreign substances to a vitreous body. W. J. WINNINGHOFF (General Electric Vapor Lamp Co.). U. S. 2,056,637, Oct. 6, 1936 (Jan. 26, 1931; renewed May 14, 1935).

Drawing glass sheets. W. O. AMSLER (Simplex Engineering Co.). U. S. 2,057,357, Oct. 13, 1936 (May 16, 1934).

Making bottles and like articles of hollow glassware. G. E. ROWE (Hartford-Empire Co.). U. S. 2,059,147, Oct. 27, 1936 (March 28, 1934).

Making lenses. E. J. REH (Bausch & Lomb Optical Co.). U. S. 2,054,166, Sept. 15, 1936 (Feb. 24, 1934).

Producing concave crystals. E. R. BOYLES AND C. R. MOON (John R. Johnston, Jr.). U. S. 2,057,763, Oct. 20, 1936 (Dec. 19, 1934).

Ophthalmic lens. J. C. WELLS (American Optical Co.). U. S. 2,054,351, Sept. 15, 1936 (July 12, 1933).

Ophthalmic lens and method of making. C. L. BAUSCH (Bausch & Lomb Optical Co.). U. S. 2,057,179, Oct. 13, 1936 (Nov. 11, 1933; renewed April 23, 1936).

Polymerization of methacrylonitrile. TRIPLEX SAFETY

GLASS CO., LTD., AND J. WILSON. Brit. 453,521 and 453,578, Sept. 23, 1936 (March 13, 1935).

Process and apparatus for annealing glass sheets. E. I. BROWN (Pittsburgh Plate Glass Co.). U. S. 2,057,816, Oct. 20, 1936 (Jan. 10, 1935).

Process and furnace for making mineral wool. E. R. POWELL (Johns-Manville Corp.). U. S. 2,057,393, Oct. 13, 1936 (July 27, 1928; renewed Jan. 21, 1935).

Process for luminous flame heating. W. A. MORTON (Amco, Inc.). U. S. 2,056,531, Oct. 6, 1936 (May 22, 1933). The method of producing a controlled luminous flame in an industrial heating furnace comprises premixing fuel gas and waste gases of combustion, introducing the mixture into the furnace in the form of a stream and maintaining ignition of the mixture, introducing into the furnace a substantially parallel stream of air in such proximity to the first-mentioned stream as to cause diffusion of the streams, and controlling the degree of luminosity of the resulting flame by regulating the rate of diffusion by varying the spacing between the streams at the points of their admission to the furnace.

Process of manufacturing inside frosted bulbs. TOMISABURO NARUSE. U. S. 2,054,707, Sept. 15, 1936 (March 21, 1933).

Toughening or hardening of glass or glass objects. H. C. HEIDE (F. Eckert). Brit. 454,374, Oct. 14, 1936 (March 26, 1935).

Vacuum feeder. G. R. HAUB (Shawkee Mfg. Co.). U. S. 2,058,149, Oct. 20, 1936 (Oct. 27, 1932).

Structural Clay Products

Attack of brick and masonry by salts. R. RUTGERS. *Klei*, **27** [12] 101–102; [13] 109–10; [15] 122–25 (1935); abstracted in *Chim. & Ind.*, **36** [2] 337–38 (1936).—Efflorescences are formed by calcium sulfate, the calcium being derived from the clay and the sulfur from the clay and flue gas, and by sodium and magnesium sulfate, etc. According to experience, the sulfate concentration in the masonry, below which there is no risk of disintegration by local accumulation of salts, is between 0.15 and 0.35% SO_3 (sodium sulfate), with a higher limit for calcium sulfate. Baryta added to cement neutralizes flue gas for a certain time and is transformed into the insoluble sulfate, but its effect is limited. M.V.C.

Choice of pipe material for sewers: VIII, How pipes should be tested. HUGO BRONNECK. *Clay Prod. Jour. Australia*, **3** [12] 21–25 (1936).—The investigations which should precede a decision on what material of pipe shall be used are (1) chemical examination of the soil, underground water present in the soil, and all waters and effluents which are to flow through the pipe; (2) testing pipes, chemically and mechanically; (3) conditions of slope of the pipe system; (4) best cross-section of pipe. Under (1) it is noted that a natural soil may be less harmful than one which contains refuse from buildings or factories, scoria, and nitrogenous organic waste. Under (2), testing pipes for erosion should not be done on the rotating pipe, but so that the trough of the pipe always shows the same surface. For Parts **V–VI** see *Ceram. Abs.*, **15** [11] 334 (1936). H.H.S.

Contributions to the study of florescence: VII, Relation of soluble salt content to florescence. B. BUTTERWORTH. *Trans. Ceram. Soc.*, **35** [3] 105–22 (1936).—No definite correlation between the total soluble salt content of a brick and its liability to florescence as estimated by two methods, the absorption of water at room temperature and at the boiling point, appears to exist. It was found, however, that the determination of water-soluble magnesium can be used as a means of distinguishing between tendencies of brick to floresce and that florescence is marked if its content exceeds 0.05%. For Part **VI** see *Ceram. Abs.*, **13** [3] 61 (1934). R.H.H.P., JR.

Domestic materials for water-pipe lines. E. NAUMANN. *Gas- & Wasserfach*, **79** [37] 674–77 (1936).—Pipes made of German materials, clay, porcelain, glass, etc., are described, and methods of metallic packing, especially with Al foil, are discussed. M.H.

Effect of frost and humidity on the resistance to pressure of paving tile. ESSE. *Tonind.-Ztg.*, **60** [35] 441–42; [36] 457–58 (1936).—Results of tests to determine the effect of frost and humidity on paving brick are tabulated. M.V.C.

Fifty years of Fletton brickmaking. THOMAS WHITEHOUSE. *Master Builder*, **41** [885] 549–53 (1936).—The development of the Fletton industry from 1877 to the present time is traced. M.V.C.

Lime in clay; a case from practice. ANON. *Tonind.-Ztg.*, **60** [54] 669 (1936).—The injurious effect of lime, present in clay, on brick is discussed. The addition of coal to the brick mix counteracted the effect of the lime and improved the brick quality. M.V.C.

Manufacture of salt-glazed stoneware pipes and fittings: XVI. A. COULHON. Translated in *Brit. Clayworker*, **45** [534] 200–202 (1936).—C. describes arrangements designed and patented by Ooms for handling and trimming pipes. In one hour, two of the machines and three semi-skilled workmen handle 180 pipes, 1 meter long and 7 to 8 in. in diameter, which are made in the usual manner. For Parts **XIV–XV** see *Ceram. Abs.*, **15** [11] 337 (1936). R.A.H.

Phenomena occurring during steam-hardening of lime-sand brick. A. W. WOLSCHENSKY. *Tonind.-Ztg.*, **60** [34] 429–31; [35] 445–46 (1936).—The effect of water on silica and studies made on the subject are discussed in detail. M.V.C.

Pipe sleeve joints with caoutchouc packing. M. KOOTZ. *Gas- & Wasserfach*, **79** [37] 677–78 (1936).—Some uses of caoutchouc as packing material for water lines with more than 20 atm. pressure are briefly described. M.H.

Salt content of water used for brick clay. WALTER MARSCHNER. *Tonind.-Ztg.*, **60** [50] 617–18 (1936).—Results of the study of the SO_3 and barium carbonate content of water used for brickmaking in German brick plants are tabulated. M.V.C.

Sewage work employs thousands. T. H. UPTON. *Clay Prod. Jour. Australia*, **3** [11] 5 (1936).—The Sydney metropolitan sewerage plan is employing 8000 extra men

on location and 5000 extra in the pipe factories. The cost of the plan is 15 million dollars a year for 5 years.
H.H.S.

Testing drain pipes for their resistance to vertical pressure. ANON. *Tonind.-Ztg.*, **60** [33] 420–21 (1936).—A project for standard tests for drain pipes of brittle materials such as concrete, fired clay, stoneware, and asbestos cements is described. M.V.C.

Thermo-insulating froth-diatomite brick. YA. M. KHANANOV. *Stroitel. Material.*, No. 3, pp. 18–22 (1936).—A froth of the root of *Saponaria officinalis* was mixed with clay in zinc-lined boxes and dried 3 to 4 hr. at 50° to 60° and then at 90° to 100°. The firing was done at about 900°C. The quality of the brick obtained surpassed all known foreign kinds of thermo-insulating brick (volume weight (g./cm.^{3}) 0.285 to 0.500; compressive strength, 10 to 19; thermal conductivity at t = 80°, 0.06 to 0.86).
P.B. & E.S.

Wall stops transformer noise. ANON. *Elec. World*, **105** [15] 1816 (1935).—A 3000-kva. transformer, which produced noise objectionable to a dwelling 150 ft. above the substation, was surrounded by a brick wall carried above busbars, thus deflecting sound. E.H.McC.

BULLETIN

Production of an insulating brick using North Carolina shales. A. F. GREAVES-WALKER, W. C. COLE, AND S. C. DAVIS. *Univ. of N.C. Eng. Expt. Sta. Bull.*, No. 11 (Aug., 1936). Price 20¢.—An insulating brick to replace common backing brick in building construction was produced by the addition either of cotton seed hulls or white pine sawdust to shale. From 40 to 45% of combustible gave a product having a thermal conductivity (at room temperature) approximately half-way between that of a straight shale and Sil-O-Cel brick, over 1500 lb./sq. in. crushing strength, and a density of 82 lb./cu. ft.
R.F.R.

PATENTS

Building blocks, brick, etc. A. KNAPEN. Brit. 454,949, Oct. 21, 1936 (April 10, 1935).

Dry masonry. ERICH HONIGMANN AND FRIEDRICH BRUCKMAYER (Alexander Singer). U. S. 2,056,937, Oct. 13, 1936 (Oct. 26, 1935). In dry masonry comprising a plurality of superposed courses of brick, preformed intermediate joint means interposed between the courses, the joints means comprising inherently firm joint material consisting of vegetable fibers associated with a setting binder retaining the fibers structurally in position, the fibers and binder together serve to hold the brick in association by friction and have great tensile strength, resistance to shearing, and a general roughness imparting great compressive strength to the masonry.

Locking means for tile and brick. E. V. KERNER (Starlock Mfg. Co.). U. S. 2,054,512, Sept. 15, 1936 (June 22, 1932).

Method of making brick corners. E. H. PETTLER. U. S. 2,054,684, Sept. 15, 1936 (Aug. 21, 1934).

Mold for casting a supporting ledge for brick veneer. E. W. NAVARRE. U. S. 2,057,732, Oct. 20, 1936 (April 10, 1935).

Spacing and supporting means for brick veneer walls. JERRY HORNICEK (Starlock Mfg. Co.). U. S. 2,054,511, Sept. 15, 1936 (May 16, 1933).

Refractories

Action of coal slags on refractory materials. ANON. *Fuel Economist*, **11** [128] 295–96 (1936).—The chemical and physical properties of kaolin, diaspore, kyanite, silicon carbide, and chromite refractories which affect the resistance of these refractories to the corrosive action of coal-ash slags are discussed. F.G.H.

Bauxite. C. S. FOX. *Rec. Geol. Surv. India*, **70**, 352–54 (1935).—During the past few years, small quantities of bauxite refractories for furnaces have been made in an experimental manner by Burn & Co., at Raniganj, Bengal, India, and the question of preparing abrasive products has been considered. This research must be regarded only as a trial with fused bauxite and is not completed. An investigation has also been conducted by F. into the preparation of calcium-aluminate cement, which was successful on the small quantities made. Results have been satisfactory for experimental work on a small scale and an experimental plant is contemplated. A.P.S.

Bauxite of the French Sudan. V. C. *Verre & Silicates Ind.*, **7** [18] 213–14 (1936).—A high alumina content (69.10% to 74.80%) and low iron and silica content proclaim the value of Sudanese bauxites. M.V.C.

Behavior of refractory materials under torsion at different temperatures: II, Kaolin and kaolin-silica mixtures. A. L. ROBERTS AND J. W. COBB. *Trans. Ceram. Soc.*, **35** [4] 182–208 (1936).—The behavior under torsional stress at temperatures from 20 to 1100°C of kaolin, kaolin-grog, kaolin-quartzite, and kaolin-vitreous silica mixtures of corresponding grain sizes fired at 1000°C, refired at 1200°C, and three times refired at 1410°C, as well as ware fired to cone 14, has been studied. It was found that the order of the modulus of rigidity at room temperature was kaolin-grog, kaolin-vitreous silica, and kaolin-quartzite. With increasing temperature, the mixtures containing crystalline modifications of free silica showed increased resistance to torsional stress, a maximum being reached at 800 to 900°C, the range of transition from the elastic to the plastic state. In the absence of crystalline silica, the modulus of rigidity was found to remain sensibly constant. For Part I see *Ceram. Abs.*, **12** [10–11] 375 (1933). R.H.H.P., JR.

Checker brick for blast-furnace stoves. ANON. *Iron & Steel Ind.*, **9** [1] 23–25 (1935).—"Hotspur" brick is described. Three types of brick can be arranged in five zones with varying heating surface. The brick are laid on cast-iron grids around flues extending the length of the stove. A cruciform boss in the middle strengthens the brick without affecting its effective volume. A staggered

formation insures turbulent flow, and connecting passages between flues insure lateral flow of the gases. See *Ceram. Abs.*, **15** [9] 275 (1936). E.H.McC.

Checkerwork for open-hearth furnaces. W. C. Buell. *Steel*, **97** [Sept. 23] 81–86; [Sept. 30] 38–42 (1935).—Since checkerwork is the primary heat-exchange medium of the open-hearth system, its design and installation is highly important. Various designs of flues are illustrated and discussed. Such properties as (1) dimensional properties of selected checker brick, (2) relative fluid velocities through checkerwork, (3) exposed area in checkerwork, (4) surface areas other than checker surfaces which function as heat-exchange media, and (5) unit costs of various types of flues are listed. Possible improvements in the typical furnaces are also suggested. H.E.S.

Coke-oven door brick. C. Koeppel. *Glückauf*, **71** [34] 797–805; [35] 830–34 (1936).—The causes for destruction of coke-oven brick were investigated. They were found to consist mainly in abrupt temperature changes and in the deposition of C in the interior as a consequence of CO disintegration. To increase the life of fireclay brick, this disintegration can be prevented by increasing the structural resistance against the swelling action of the disintegrated C and by shifting the temperature zone, within which the iron oxides of the brick accelerate the disintegration, to lower and less endangered zones of the brick. These conditions are discussed at length and some compositions of brick which have given good resistance are described. M.H.

Density of fused alumina. H. v. Wartenberg, G. Wehner, and E. Saran. *Nachr. Ges. Wiss. Göttingen. Math.-physik. Klasse [Fachgr. II]*, **2**, 73–75 (1936); abstracted in *Chem. Zentr.*, **ii**, 444 (1936). M.V.C.

Design of regenerator chambers. W. C. Buell. *Steel*, **97** [Aug. 26] 45–50; [Sept. 2] 63–67 (1935).—The recommended development and approved designs of brickwork for regenerator chambers are presented and illustrated. The most important preliminary step is the establishment of the minimum dimensions necessary to produce satisfactory fluid flow conditions at the regenerator entrances. Details of steel structure and design are also given. See "Improving—" *Ceram. Abs.*, **15** [5] 152–53 (1936). H.E.S.

Designed suspended wall for boiler furnaces. Chicago Firebrick Co. *Steel*, **97** [Sept. 2] 67 (1935).—Illustrated. H.E.S.

Developments in production of refractories containing magnesia. L. Litinsky. Translated in *Iron & Steel Ind.*, **9** [12] 462–66; [13] 495–99 (1936); see *Ceram. Abs.*, **15** [9] 276 (1936). E.H.McC.

Distribution and flow of fluids in regenerator chambers. W. C. Buell. *Steel*, **97** [Sept. 9] 53–55; [Sept. 16] 44–47 (1935).—The influence of checker design on fluid flow is compared and illustrated. Six elevational arrangements of checker work are shown and their relative advantages or disadvantages pointed out. Any design of checkerwork will be only as effective as the distribution of the fluids over and below the checkers. H.E.S.

Economic importance of insulating refractories. J. G. Coutant. *Ind. Heating*, **3** [10] 695–98, 726 (1936).—The properties of modern insulating refractories are described, and the economic advantages accruing from their application as furnace lining materials explained. As their weight is much lower than that of fire brick or similar materials, the heat stored is reduced considerably and the fuel is utilized to a much higher degree. Actual savings and rates of furnace outputs are shown by examples. M.H.

Effect of addition of fluxes on temperatures of fusion and softening of silico-aluminous refractory products. Marcel Lépingle. *Verre & Silicates Ind.*, **7** [23] 270–74; [24] 281–85 (1936).—A series of experiments was made to determine the behavior of refractory cements during firing. These products are composed of a refractory base with an added flux. The following factors are discussed: (1) the effect of fluxes on the melting temperature, (2) the calculation of the melting temperature, (3) effect of fluxes on the softening temperature, and (4) effect of increased addition of fluxes. The results are tabulated and shown with curves. M.V.C.

Effect of drying and firing retorts on their length of service in zinc distillation furnaces. V. S. Sakolov and A. I. Vartanian. *Tsvetnuie Metally*, **10** [10] 31–39 (1935); abstracted in *Chim. & Ind.*, **36** [3] 525 (1936).—The composition of the ceramic retorts studied was 28.89% grog, 61.69% clay, and 9.41% coke. They were dried one month by raising the temperature 1° to 2° every 24 hr. from 18° to 56°C. This method is suitable for these retorts. Not more than 1% hygroscopic water should remain at the end of the drying period. Strictly reducing firing conditions should be maintained at a temperature of 950°; higher temperatures affect the quality. Linear shrinkage in air does not exceed 5%; shrinkage on firing is 0.50% and varies according to the firing temperature. M.V.C.

Electric rotary clay gun. Anon. *Iron & Steel Ind.*, **9** [4] 145–46 (1936).—A device for stopping blast-furnace tap holes extrudes clay in a continuous stream. The gun is hung on swinging arms and a steel-plate carriage and is operated by remote control. See *Ceram. Abs.*, **15** [5] 151 (1936). E.H.McC.

Expansion of refractories at temperatures up to 2000°C. H. Ebert and C. Tingwaldt. *Physik. Z.*, **37**, 471–75 (July 1, 1936); abstracted in *Science Abs.*, **39** [464] 859 (1936).—An "absolute" method of determining the expansion in air is described. The oven used consists of an electrically heated "Nernst" tube, in which a shuttle containing the test piece is placed. The tube has three equally spaced through-holes. The ends of the test piece are observed in the outermost holes by a pair of micrometer telescopes. An optical pyrometer is mounted so that it can be trained on each of the three holes from the opposite side to the micrometers. Results are given for sintered corundum, magnesia, and zirconia. The expansion of corundum is more constant and repeats more exactly than that of the other materials and is therefore most suitable for use in "relative" methods of determining expansion. H.K.R.

Experiments on chrome-silica brick: I. T. R. Lynam and W. J. Rees. *Bull. Brit. Refrac. Research Assn.*, No. 26 (Aug., 1931); reprinted in *Trans. Ceram. Soc.*, **35** [3] 138–52 (1936).—Experiments with briquets made from silica and chrome-brick batches mixed in all proportions and fired under industrial and laboratory conditions are

reported. It was found that silica-chrome brick mixtures from about 3:1 to 1:1 are mechanically stronger at high temperatures, as determined by load and tensile tests, than a chrome brick, have a smaller expansion coefficient than a silica brick, and show a greater resistance to spalling than either a chrome or silica brick. Further, the degree of vitrification of a chrome brick is increased by the addition of small quantities of silica. II. *Bull. Brit. Refrac. Research Assn.*, No. 28, pp. 28–40 (Aug., 1932); reprinted in *Trans. Ceram. Soc.*, **35** [3] 153–65 (1936).—High-temperature tensile and under-load tests show that the addition of 2.5% silica to a chrome-brick batch increases the toughness and strength of the brick at the higher temperatures. Slag tests and a variety of service tests of the silica-chrome mixtures of Part I show that they are as resistant as a chrome brick to slags having a high iron content, but they are not as durable under the influence of high lime slags, such as are produced in the basic open-hearth furnace. R.H.H.P., JR.

Factors for calculating thermal effects in regenerators. W. C. BUELL. *Steel*, **97** [Oct. 7] 53–61; [Oct. 14] 55–57; [Oct. 21] 54–58 (1935).—For the analytical study or consideration of thermal actions and reactions in regenerators, definite information is required as to the entering and leaving temperatures of all fluids passing through each regenerator, the quantity of heat contained in the several fluids when entering and leaving each regenerator, the exposed surface area of the checkerwork and the containing structure which will act as heat-exchange media, and the velocity of the several fluids during their passage through each regenerator. H.E.S.

Further experiments with special refractory brick for crowns of electric furnaces. HUBERT KRAL. *Stahl & Eisen*, **56** [36] 1000–1002 (1936).—The behavior of Magnesidon brick (2% SiO_2, 1.5% Fe_2O_3, 0.2% Al_2O_3, 2% CeO, 94% MgO), Bikorite brick (99.5% Al_2O_3, and some SiO_2, Fe_2O_3, and Na_2O), Dioxilite brick (pure quartz), Alusil (corundum brick with 83 to 85% Al_2O_3 and less than 1% Fe_2O_3), Chromodur brick (a chromite brick), and Magnosil brick (a Norwegian natural rock) was studied. The results show that these brick are unsatisfactory for crowns. Some of them are not sufficiently stable; others melt and soil molten steel. They are also too expensive. Therefore, the question of finding a refractory and an economic refractory material for crowns of basic electric furnaces remains open. M.V.C.

Gas retort and coke-oven repairs by cement spraying. E. J. CRAWLEY. *Refrac. Jour.*, **12** [7] 368 (1936); *Coal Carbonization*, **2** [8] 152 (1936).—C. reports that an effective method of repairing oven refractories is to spray a cement on the worn brick and joints. The cement to be used should be carefully chosen and should mix easily with water and form a slurry which remains in complete suspension during the time of spraying. The cement slurry should dry quickly without blistering or flaking and should flow easily through the spraying apparatus. The volume change of the cement when sprayed on hot brickwork should be negligible; the cement should vitrify at the working temperature of the furnace and adhere rigidly to the brickwork. Two illustrations. M.C.S. + G.T.

General Refractories, Ltd. F. S. RUSSELL. *Electrician*, **116** [14] 468 (1936).—F. gives a summary of financial operations in which is noted "Saxpyre" brick, a brick of entirely new character that, while withstanding the most intense heat, will also resist the action of basic slags and corrosive atmospheres without spalling or cracking. It fills a want long felt by producers of basic steel. H.K.R.

Heat resistance of insulating materials. H. BATSCH AND A. MEISSNER. *Z. tech. Physik*, **17** [8] 283–85 (1936).—A new equipment for measuring the heat resistance of insulating materials is described. Experiments are carried out in the vacuum, the materials being kept in position by an electromagnet. W.M.C.

High-grade ores for aluminum manufacture. ANON. *Eng. Mining Jour.*, **137** [9] 460–61 (1936).—Many clays and shales contain 40% or more aluminum oxide, but these are not economical sources of aluminum since they contain from 35 to 50% silica, every pound of which requires a pound of soda ash to remove it in the Bayer process of alumina purification. This silica also carries away with it about the same amount of alumina. Acid-purification processes do not dissolve the silica but have the disadvantage that they do not permit the ready separation of the contaminating iron oxide. Producers of pure aluminum, therefore, must still use bauxite ore which is from 57 to 62% alumina with low silica content, about 1.5 to 5.5% SiO_2. J.L.G.

Improving open-hearth furnace design: Heat exchange in regenerators. W. C. BUELL, JR. *Steel*, **97** [Oct. 28] 46–50 (1935).—A quantitative method of determining heat exchange in regenerators developed by B. is presented in detail. **Flues.** *Ibid.*, [Nov. 4] 58–62; [Nov. 11] 56–64. The recommended construction of flues is illustrated. The merits of steel and brick stacks are discussed. **Valves.** *Ibid.*, [Nov. 18] 60–64; [Nov. 25] 47–55.—Details in typical furnaces in regard to valves installed are shown. Similar data on stack and waste-heat boiler dampers are also given. **Waste-heat boilers.** *Ibid.*, [Dec. 2] 50–53; [Dec. 9] 38–40.—Waste-heat boilers are used to salvage or recover the secondary heat from the furnace gases in nearly all larger open-hearth installations. The history and development of waste-heat boilers are outlined and the various types are illustrated and discussed. B. points out the general advantages of steam around open-hearth plants, especially where producer gas, oil, or tar is the fuel. General data and heat balance as well as capital and operating and labor costs for proposed waste-heat boilers are given. The net credit due to utilizing waste heat in steam is shown to be about 16.5¢ per ton ingots where producer gas is used as fuel and about 0.78¢ where fuel oil is used. **Summary.** *Ibid.*, [Dec. 16] 53–56; [Dec. 23] 45–48, 54.—The subject of open-hearth design is considered under two dissimilar categories, (1) the use of the engineering materials in the construction of the furnace and system, and (2) the effects of the flow of fluids of the process within the structure which are incident to operation. Flow diagrams which are drawn from the data of fluid velocity afford a visual comparison of furnace design and operation. The general analyses developed and principles expounded have common application to any high-temperature application or process using combustion heat. H.E.S.

Innovations in American open-hearth operation. CARL SCHWARZ. *Stahl & Eisen*, **56** [38] 1138–46 (1936).—A

discussion of papers read at the 19th meeting of the Open-hearth Committee of the American Institute of Mining and Metallurgical Engineers, held in Detroit in April, 1936, deals with (1) progress in refractory brick, (2) construction of open-hearth furnaces, (3) measurement and control and supervision, (4) metallurgical problems, and (5) tapping and casting steel. M.V.C.

Insulation of open-hearth furnaces. E. ORCHARD. *Iron & Steel of Canada*, **19** [4] 12–13 (1936).—O. describes the method used by the Algoma Steel Corp. for furnaces and checkers. M.H.

Investigations on alumina. T. NAKAI AND Y. FUKAMI. *Jour. Soc. Chem. Ind. Japan*, **39** [6] 203–204B (1936).—The transformation of the crystalline structure of alumina from heat treatment, the effect of various agents upon the growth of crystals, and the increase of mechanical strength of alumina were studied. M.V.C.

Limits of thermal and temperature stressing of coke-oven walls. C. KOEPPEL. *Glückauf*, **71** [2] 33–39; [3] 60–65 (1935).—The mechanical stresses in coke-oven walls with superimposed thermal stresses are discussed at length and mechanical constructions are reviewed. The best material for this purpose is considered to be tridymite brick which does not undergo structural changes in the usual temperature range of operation of coke ovens. Suggestions for arranging tie-bolts and constructive details are added. M.H.

Manufacture of aluminum carbide, Al_4C_3. OTTO RUFF. *Chem.-Ztg.*, **60** [2] 28 (1936).—Pure aluminum shavings are mixed with powder free from ash and heated, in a closed carbon crucible, to 2000°C for 30 minutes in a hydrogen atmosphere free from nitrogen. Overheating must be avoided. The reaction product is dark orange, and its purity depends on the purity of the aluminum, carbon, and hydrogen. M.V.C.

Manufacture of national silico-aluminous refractories of high resistance. R. BURKHARDT. *Ind. Vetro & Ceram.*, **9** [3] 58–61 (1936).—B. gives a short description of Italian siliceous, aluminous, and silico-aluminous raw materials. No refractory bond clays are available. Three processes of manufacture are possible: (1) use of nonplastic material by means of strong pressure, (2) increase of plasticity of kaolin, and (3) addition of deflocculators to semi-refractory clays, allowing a small percentage of slip in the mix. B. has obtained good results with the following mixture: 3 parts Sardinian plastic clay, 50 parts kaolin, and 47 parts grog. F.E.V.

Manufacture and uses of refractories. T. McC. FIRKIN. *Jour. Australian Chem. Inst.*, **3** [9] 256 (1936).—F. gives a report of a lecture on the Newbold Silica Firebrick Co. methods of manufacture. H.H.S.

Measuring thermal conductivity. ANON. *Sprechsaal*, **68** [37] 570–71 (1935).—A discussion is given of experiments made by Ezer Griffiths (*Heating & Ventilating Engr.*, **7** [78] 223–28; [79] 270–72 (1933–34)) and by A. Roux (*Rev. Gen. Froid*, **16** [4] 98–105 (1935)) on the measurements of thermal conductivity of various insulating materials. M.V.C.

Mottled silica brick. W. J. REES. *Bull. Brit. Refrac. Research Assn.*, No. 30 (1933); reprinted in *Trans. Ceram. Soc.*, **35** [6] 284–85 (1936).—Skin mottling of silica brick is ascribed to condensation of sulfur acids and water-vapor on the brick during the early stages of firing and appears to be indicative of the presence of "dead spots" in the kiln. It does not affect the refractoriness or the subsequent behavior or durability of the brick in service. R.H.H.P., JR.

Mullite development in super-duty fireclay brick. FRED A. HARVEY AND RAYMOND E. BIRCH. *Jour. Amer. Ceram. Soc.*, **19** [11] 322–27 (1936).

Obtaining alumina from bauxite. J. PAP. *Magyar Chemiai Folyóirat*, **41** [1–5] 55–65; [6–9] 119–29; [10–12] 137–49 (1935); abstracted in *Chim. & Ind.*, **36** [3] 537 (1936).—When solutions of aluminum sulfate mixed with ammonia (including basic soluble aluminum sulfate and hydrated alumina in suspension) are heated in an autoclave under pressure, an insoluble crystalline precipitate which is a basic sulfate of aluminum and ammonium of the composition $6Al_2O_3 \cdot 7SO_3 \cdot 2(NH_4)_2SO_4 \cdot 18H_2O$ is formed by hydrolysis. When 1 mol. of aluminum sulfate in concentrated solution (2.5 mol. ammonia) is added, 82.0% aluminum sulfate separates at 120°C, and 96.7% separates at 180°C in a form of precipitate easily filterable and of the above composition. Ferrous sulfate, ferric oxide, silica, and titanium are eliminated. When the basic sulfate of aluminum, filtered and dried, is mixed with ammonium sulfate to obtain the mixture $Al_2O_3:SO_3 = 1:4$ which is heated, first ammonia is liberated; then, at 550°, ammonium sulfate, so that only aluminum sulfate remains. At 700°C, the latter decomposes and the residue contains only 99.55 to 99.94% alumina. M.V.C.

Practical experience with lining basic and acid bottoms of open-hearth furnaces: I, Lining basic bottoms. HEINRICH JOSEPH MEYER. *Stahl & Eisen*, **56** [29] 815–18 (1936). **II, Lining acid bottoms.** HEINRICH ABKER. *Ibid.*, pp. 818–19 (1936).—The following points are discussed: (1) the effect of firing with different compositions of dolomite; (2) relining and melting down of basically lined bottoms; (3) lining the backwall; (4) magnesite lining for bottoms; (5) quartz-sand lining for bottoms; (6) effect of the nature of sand on durability; and (7) patching of bottoms. M.V.C.

Practical hints for the manufacture of tank blocks. G. *Tonind.-Ztg.*, **60** [60] 741–42; [61] 750–51 (1936).—It is not necessary to age refractory mixes for tank blocks for 6 to 12 months; it is more advisable to use this time for drying, firing, and cooling. With careful shaping and handling during drying, more resistant blocks are obtained. Blocks of larger size should have a smaller number of joints and, in this way, the life of the blocks is increased. M.V.C.

Production of aluminum from German raw materials. FRITZ GEWECKE. *Chem.-Ztg.*, **60** [13] 133–35; [15] 155–58 (1936).—Various methods developed for obtaining alumina from bauxite and clays are enumerated and discussed. M.V.C.

Properties and manufacture of refractories. C. W. DEATH. *Jour. Australian Chem. Inst.*, **3** [9] 256 (1936).—D. outlines the Australian Glass Co. processes. H.H.S.

Ramming blast-furnace bottom and boshes with carbon-tar material. FRANZ WEINGES. *Stahl & Eisen*, **56** [30] 845–47 (1936).—The use of a monolithic carbon-tar mixture for the bottom and boshes of a blast furnace are

described. The results obtained were good. Illustrated. M.V.C.

Refractory brick for lining cement furnaces. ANON. *Ceramica*, No. 56 (June, 1936); abstracted in *Verre & Silicates Ind.*, **7** [25] 300 (1936).—Refractory brick for the hottest parts of the furnace should have a resistance equal to Seger cone 34 (1750°); a good lining should last 10 to 12 months in these parts and much longer in the cooler parts of the furnace. A mixture of clinker and cement is sometimes used for lining, but it is less resistant than brick. M.V.C.

Saggers. T. H. TIVES. *Keram. Rundschau*, **43** [42] 493–95; [43] 507–10; [44] 519–22; [45] 531–33 (1935).—With the kilns used in fine ceramics, saggers remain a necessity. Because material intended to resist quick temperature changes should be porous, its mechanical strength is limited. Breakage is often due to ignorance of this fact. It is essential that the composition of the mass, including the finest grog particles, should be adapted to working conditions. To increase resistance against temperature changes, additions of silicon carbide or fritted corundum are advisable because of high conductivity. High porosity is required, although air is insulating. For use in tunnel kilns, apparent porosity, measured by water absorption, may reach 12%; in round kilns, 5 to 8% porosity is usual. Compressive strengths are 220 to 250 and 275 to 290 kg./cm.², respectively. After seven heatings, quartz transformation decreases strength about 20%. Influence of raw materials, tests, manufacture, and drying of saggers are dealt with. F.E.V.

Screw-type pot furnace. LINDBERG ENGINEERING CO. *Steel*, **97** [Sept. 16] 50 (1935).—A pot furnace with a combustion chamber in the shape of an internal screw is illustrated. H.E.S.

Slag resistance of steelworks refractories. J. H. CHESTERS AND L. LEE. *Trans. Ceram. Soc.*, **35** [6] 271–83 (1936).—The absence of fundamental knowledge of equilibrium conditions and reaction rates makes difficult a precise study of slag attack which accounts for most failures of refractories in steelworks furnaces. Rapid laboratory methods of studying slag resistance can be employed, however, such as the cone and "pill" tests of refractory-slag mixtures and the induction-furnace melting of metal and slag in contact with refractory, a test which simulates large-scale conditions. Microscopic examination of slagged refractories and physical tests, such as modulus of rupture at high temperatures and permeability, yield data which are useful in the development of refractories of high-slag resistance. R.H.H.P., JR.

Use of Italian raw materials in the manufacture of crucibles for fusing glass. RENATO MORETTI. *Corriere Ceram.*, **17** [7] 199–203 (1936).—Italian clays and their preparation for use in the manufacture of crucibles are discussed. M.V.C.

Utilization of alunite through alkali fusion. J. A. TAYLOR AND F. K. CAMERON. *Ind. Eng. Chem.*, **28** [10] 1238–39 (1936).—Alunite can be sintered satisfactorily with potassium sulfate, potassium carbonate, and coal in Alundum-lined furnaces. The sinter can be leached and alumina can be precipitated in satisfactory purity from the leachings. The mother liquor contains potassium sulfate and potassium carbonate. By evaporation, the sulfate can be obtained practically quantitatively and in high purity. The residue of carbonate with water and a small proportion of sulfate can be satisfactorily used for decomposing the alunite. F.G.H.

Working of Zobten magnesite. G. GERTH AND A. BAUMGARTEN. *Chem.-Ztg.*, **60** [17] 177–78 (1936).—The magnesite deposits of Zobten are briefly discussed, and means of working them are described. Magnetic separation and flotation for treating magnesite are dealt with. M.V.C.

Youngs' modulus of elasticity, strength, and extensibility of refractories in tension. R. A. HEINDL AND L. E. MONG. *Jour. Research Nat. Bur. Stand.*, **17** [3] 463–82 (1936); R.P. 923. Price 5¢.—The tensile properties were determined at ordinary temperatures upon the following materials in tension: sixteen brands of fireclay brick with a wide range in silica content, representing the stiff-mud, dry-press, and handmade methods of forming; and one brand each of silica brick, chrome, forsterite, 60% alumina, 80% alumina, and of mullite. The chemical composition, porosity, pyrometric cone equivalent, and method of manufacture for most of the materials are included. A testing machine of the simple lever type, especially constructed for the study, is described. Deformation measurements were obtained with the Tuckerman optical strain gage, which permitted readings to be duplicated to within 0.000002 in. Three methods of obtaining specimens from the individual brick were tried, and the results of tests on selected specimens are given. In the method adopted, three specimens were machined from each brick, two lengthwise and one crosswise. The lengthwise specimens provided a 3-in. gage length and the crosswise provided a 2-in. gage length. All specimens had a cross-sectional area of 1.50 sq. in. gage length. The following results were obtained: (1) based on strength and Young's modulus of elasticity of fire brick in tension, for the brick sampled both lengthwise and crosswise, the brick may be generally classified into three types as follows: (*a*) these properties are approximately alike irrespective of the direction of sampling (handmade brick were of this type); (*b*) these properties of lengthwise specimens are greater than those of the crosswise specimens (stiff-mud brick type); and (*c*) modulus of elasticity of the crosswise specimens is greater than that of the lengthwise specimens and the strengths are approximately equal (most of the dry-pressed brick were of this type). (2) The range in extensibilities for all brands of brick is from 0.0120 to 0.0465%, but the majority of fire brick are grouped within the comparatively narrow range from 0.0175 to 0.0235%. A highly siliceous fireclay brick and a silica brick, with higher silica content than the other brands and both formed by the handmade process, had extensibilities much greater than the other brands. (3) In general, brick formed by the dry-press process had greater extensibilities than those formed by either the handmade or the stiff-mud process. (4) When comparing the tensile properties of several brick of the same brand, handmade brick were more variable from one brick to the next than either stiff-mud or dry-pressed brick. The range from maximum to minimum values for individual brick, however, is less for the handmade brick than for either of the other types. (5) From the limited data obtained on brick fired under no load when compared with

those fired under a load of 13 courses (stress approximately 4.4 lb./in.^{2}), it was noted that the tensile properties of the specimens subsequently cut from the brick were significantly affected by axial load during heating. It is probable that the properties were also affected somewhat by lateral load, although no data were obtained to evaluate this effect. In those brick fired under a load of 13 courses, the difference in the modulus of elasticity and in the strength lengthwise and crosswise was greater in the brick fired on end than in those set edgewise or flatwise. Of the methods, the end setting also had the highest modulus of elasticity and strength and the lowest average extensibility. In general, the modulus of elasticity of dry-pressed brick increased with the weight of the brick. R.A.H.

BOOKS

Effect of lime on the properties of silica brick. I. S. Kaĭnarskiĭ. *Ukrain. Nauchno-Issled. Inst. Ogneuporov & Kislotouporov*, No. 35, 90 pp. (1935); abstracted in *Referat. Silikatliteratur*, No. 1962 (1936).—It was found that the introduction of coarse-grained lime slip into the silica mix lowers the mechanical strength of the brick, promotes the transformation of quartz into cristobalite, and increases the ratio of cristobalite to tridymite. The introduction of calcium oxide in the form of finely ground chalk yields a silica brick with a high tridymite content and increased mechanical strength. Impure lime containing Al_2O_3, Fe_2O_3, and MgO has a better effect than pure lime. Even small amounts of finely distributed and intimately mixed oxides of Fe, Al, and Mg promote the tridymitization of quartz grains. See also *Ceram. Abs.*, **14** [9] 219–20 (1935). M.V.C.

Soviet Science. J. G. Crowther. Kegan Paul, London, 1936. On pages 257 to 260, the Ceramic Institute, Kharkov, Russia, is described. The Institute has been founded to adapt to Russian conditions the ceramic industries and to assist the birth of new factories such as that of the Pantelemonovka Silicate Factory in the Donbas, which is designed to produce 88,000 tons of refractories a year. The director, Pines, has succeeded in making satisfactory linings for Bessemer furnaces, which consumed linings more quickly than Martin furnaces. His experiments on blowing gases, *e.g.*, HCl into liquids such as solutions of NH_3, showed that the phenomena produced are similar to those which occur between the airblast and the impurities of the Bessemer furnace. By applying the theory of vortex motion, P. has stated a mathematical theory of the rate at which linings will be consumed. In furnaces of various designs, he found, experimentally, that the brick in the wall lining are wasted 300.30, or only 4 times as quickly as the brick in the floor lining; these ratios are in accord with his mathematical calculations. The Institute also makes physical-chemical measurements, the calorimetric work being done in a diphenylmethane calorimeter designed by Szukharev. H.H.S.

PATENTS

Furnace structure. J. E. MacDonald. U. S. 2,058,810, Oct. 27, 1936 (April 13, 1936). The combination with a furnace having a roof and a skewback member, of a row of skew brick interposed between the roof and the member, the brick having offsets formed on their opposed faces and arranged in interlocking relation to restrict relative movement of the brick in directions transversely of the skewback member, the offsets being in the form of coöperating bosses and recesses which have limited clearance in directions transversely of the member.

Furnace wall structure. A. S. Barker. U. S. 2,059,766, Nov. 3, 1936 (June 20, 1933).

Method and apparatus for molding refractory blocks, etc. P. G. Willetts (Hartford-Empire Co.). U. S. 2,057,466, Oct. 13, 1936 (June 16, 1934).

Process of producing pure alumina and crude potassium sulfate from alunite. Nihon Denki Kogyo Kabushiki Kaisha, S. Yonemura, T. Okazawa, and K. Osada. Brit. 454,331, Oct. 14, 1936 (Aug. 6, 1935).

Process of recovering alumina from aluminous materials. R. C. Folger (Electric Smelting and Aluminum Co.). U. S. 2,058,145, Oct. 20, 1936 (June 27, 1934).

Refractory. M. J. Rentschler. U. S. 2,057,348, Oct. 13, 1936 (March 9, 1936). A refractory body has a portion composed of an intimate mixture of finely divided carbon, granular coke, and finely divided clay and a surface portion composed of fired clay.

Refractory. M. J. Rentschler. U. S. 2,057,349, Oct. 13, 1936 (May 22, 1936). In a process of making a refractory body, the steps consist in forming such body of an intimate mixture, substantially free from volatile matter, of finely divided carbon, granular coke, and finely divided clay, drying the body, and subjecting it to an oxidizing atmosphere at a temperature of about 1800°F to about 2800°F until the carbon content is removed from an outer portion thereof to the desired depth.

Refractory article. Carborundum Co. Brit. 454,599, Oct. 14, 1936 (April 19, 1934).

Refractory article and method of making. Carborundum Co. Brit. 454,947, Oct. 21, 1936 (April 17, 1934).

Terra Cotta

Architectural terra cotta and faience. G. N. Hodson. *Trans. Ceram. Soc.*, **35** [1] 43–51 (1936).—With a brief historical background, the present methods of tile and faience manufacture and the processes of clay preparation, drying, glazing, firing, and fixing the completed ware are described. R.H.H.P., Jr.

Ceramic high-frequency condensers. H. Handrek. *Arch. Tech. Messen*, No. 62, pp. T112-13, F15 (1936).—The special ceramic materials into which the metallic layers of the condenser are fired are described. The electric properties of such masses, Calit, Calan, Condensa, and Tempa, are compiled in tables. The dielectric layers usually consist of Ag of 2/1000 to 10/1000 mm. which are fired directly into the mass at 750°C so that no intermediary (air or gas) layer exists between metal and insulator and, therefore, the condenser has no dielectric losses. Several types are described. 19 references. M.H.

Defectively fired flowerpots. P. Thor. *Tonind.-Ztg.*,

60 [35] 444 (1936).—Causes of defects which appeared in flowerpots fired in overhead flame furnaces are discussed. M.V.C.

Discoloration of wall tile by plant organisms. K. LAMCKE AND R. KÜHN. *Keram. Rundschau*, **43** [48] 567 (1935).—Wall tile occasionally takes a green color, especially in dairy rooms. The dendritic aspect of discolorations was first attributed to new mineral formations, probably of vanadium or molybdenum. Microscopic investigation, after destruction of glaze, shows the presence of green algae whose sporules have deposited in clefts of the glaze. F.E.V.

Easily fusing leadless glazes for covering face tile from Ukrainian brick clays. M. V. ALEXEEV AND E. M. KHVOROSTYANSKAYA. *Stroitel. Material.*, No. 5, pp. 25–31 (1936). P.B. & E.S.

Efficient manufacture of tile. RUDOLF BYCZKOWSKI. *Tonind.-Ztg.*, **60** [62] 763–64; [63] 776–77 (1936).—Clays suitable for the manufacture of tile and methods used are discussed in some detail. M.V.C.

Fireplace of today. ANON. *Art in Australia*, **3** [64] 106–108 (1936).—The design of the chimney, proportion of the fireplace, and size of the brick or glazed tile in proportion to the size of the fireplace are discussed. Illustrated. H.H.S.

Flowerpot manufacture. JOSEF GREIVE. *Tonind.-Ztg.*, **60** [57] 701–703; [58] 713–14; [59] 728–29 (1936).—Details of the manufacture of flowerpots and of the furnaces used are given. Illustrated. M.V.C.

Manufacture of loam glazes. GEORG HOCHHAUSER. *Tonind.-Ztg.*, **60** [42] 527–28; [43] 542–44 (1936).—The uses, raw materials, composition, application, and calculations of loam glazes are discussed in detail. [NOTE: Apparently similar to slip clay.—Editor]. M.V.C.

Manufacture of terra sigillata. F. LINDENER. *Keram. Rundschau*, **44** [13] 151–53 (1936).—The following theories have been evolved: (1) a thin glaze of clay, silica, alkalis, and eventually boron oxide, (2) an engobe with fluxes, (3) salt glazing, and (4) polished engobe. These hypotheses must be rejected. See "Pottery," *Ceram. Abs.*, **15** [8] 249 (1936). F.E.V.

Methods and materials. ANON. *Trade & Eng.*, **38**, 26 (1936).—A warning that the "science" of building is modern and that in its development new materials and variations of existing ones are certain to be found is given. The increasing use of standard specifications for building materials is advised. Concrete and sand-lime brick are "proving quite successful." Pre-cast colored concrete briquets to simulate brick facings and vibrated concrete are suggested. The need for improved sound insulation is stressed. Hollow blocks for floors and walls are regarded favorably in general terms. A.B.S.

Mosaic pavement uncovered at Tripoli. ANON. *Stone*, **55** [4] 172 (1934).—Excavation operations in Tripoli have resulted in the discovery of a remarkably well-preserved mosaic inset in an ancient Roman villa. Composed of minute fragments, its colors are still brilliant and the design is geometrical. The center contains a representation of Orpheus with his lyre and in the other squares are still life and *genre* subjects. The mosaic is large and one of the finest examples yet discovered of this ancient Roman art. W.F.F.

Persian Islam architecture. R. BYRON. *Asia*, **35**, 284–89 (1935).—A description of previously unrecorded buildings, characteristic of various periods from 1000 A.D. to 1600 A.D. is given. They are usually constructed of brick, sometimes glazed; some have inlaid faience work. The interiors are richly decorated. W.D.F.

Practice of de-aired roof tile. A. C. HEIL. *Tonind.-Ztg.*, **60** [55] 680–82 (1936).—Directions for the manufacture of dense and bubble-free roof tile are given. Illustrated. M.V.C.

Proper mortar mixtures and calking compounds for fountain. J. R. KAUFFMAN. *Keram. Tile Jour.*, **8** [7] 6 (1936).—It is recommended that the mortar to be used for setting tile in an outdoor fountain should be proportioned as follows: 1 part Portland cement, 3 to 4 parts clean, well-graded sand, and $^1/_2$ to 1 part lime putty. If water is used in the pool the year round, the mixture may be slightly richer with 1 part Portland cement, 3 parts sand, and as low as $^1/_4$ part lime putty. M.C.S.

Royal Institute of British Architects. G. GWENNET. *Clarté*, **8** [4] 10–15 (1935).—Motives decorating the interior of the new building of this Association are dealt with. Illustrated. R.W.D.

Standardization of roofing tile. R. L. PEVZNER. *Stroitel. Material.*, No. 2, pp. 31–32 (1936). P.B. & E.S.

Tile production in Moscow district. R. M. GURVITCH. *Stroitel. Material.*, No. 2, pp. 33–42 (1936).—The work of collective farm roofing tile plants is described and illustrated. P.B. & E.S.

Warpage of glazed wall tile in final heating. L. TONTSCHEFF. *Keram. Rundschau*, **44** [13] 150–51 (1936).—Convex warpage is due to a too high expansion coefficient of the mass. To reduce the expansion coefficient, decrease quartz and duration of grinding, partly substitute kaolin for plastic clay, increase feldspar, and reduce temperature if possible. A thinner glaze is frequently commendable. F.E.V.

PATENTS

Acidproof tank. RICHARD NEUHAUS (Nukem Products Corp.). U. S. 2,054,587, Sept. 15, 1936 (June 6, 1935).

Process of producing acidproof pottery. K. TILSCHER. Brit. 454,475, Oct. 14, 1936 (Jan. 17, 1936).

Structural tile and method of making. WILLIAM MCCOY (American Encaustic Tiling Co., Ltd.). U. S. 2,056,069, Sept. 29, 1936 (Aug. 20, 1931).

Whiteware

Ceramic and dielectric properties of TiO_2–MgO–ZrO_2 bodies. R. RIEKE AND A. UNGEWISS. *Ber. deut. keram. Ges.*, **17** [5] 237–64 (1936).—A survey of seventy-eight bodies of the possible two-phase and three-phase systems between TiO_2, MgO, and ZrO_2 is given. Twenty-four of the bodies which fired to a dense body at cone 16 were selected for further investigation. The melting point of all the bodies was above cone 27 (1610°). TiO_2-MgO bodies with more than 35% MgO have a dense, white body, with increasing shrinkage as the MgO content in-

creases. A body of MgO with only 9% TiO_2 vitrifies at cone 16. The fired color alters from the dark brown of the TiO_2 through light brown to gray, until those containing over 35% MgO are pure white. All are well crystallized and the white bodies are highly transparent. TiO_2–ZrO_2 bodies with 16% ZrO_2 or less are vitreous at cone 16, with a shrinkage of 18 to 20%, while those with a greater ZrO_2 content collapse in firing. The fired color resembles that of TiO_2, becoming lighter with increasing ZrO_2 content until, with more than 70% ZrO_2, the color becomes pure white. All bodies of the MgO–ZrO_2 series are vitreous. The shrinkage increases with the MgO content and attains the highest values of all the studied bodies. In the three-phase system, the MgO content has the greatest influence on vitrification, with 25% MgO as the limit. If the TiO_2 content is too high, not even 30% MgO will produce a vitreous body. Bodies with the same MgO content and a low TiO_2 content show better vitrification than those having a high TiO_2 content, with the same ZrO_2 content. MgO increases the shrinkage and decreases the water absorption with a high TiO_2 content. The fired color is chiefly white, except with a high TiO_2 content. The twenty-four bodies, dense at cone 16, were studied as to their composition after firing, by treatment with 10% NH_4Cl solution, by determining their specific gravity, and in some cases by X-ray methods. After firing, bodies made from MgO and TiO_2 consist of magnesium orthotitanate and possibly free MgO or TiO_2; on the other hand, bodies of TiO_2 and ZrO_2 consist of mixtures of the oxides, while in bodies of the three-phase system, Mg-orthotitanate, Mg-zirconate, and, depending on the composition, free MgO, TiO_2, or ZrO_2 are present. Some X-ray data are presented on ZrO_2 enclosures in the rutile lattice and the consequent change in specific gravity. Ceramic properties of the bodies are as follows: The translucency depends mainly on the content of $2MgO$–TiO_2, bodies rich in this being unusually translucent. The modulus of rupture is good and is favorably influenced by free MgO and MgO–ZrO_2, so that the highest values are obtained in the three-phase system. A definite relationship of the length of the firing period is noted here. The resistance to impact is also good but no definite relation between this factor and composition was found. The thermal expansion in all bodies was high, especially in those containing free MgO. Here again, no definite relation was found between the composition and this factor. Measurement of the dielectric constants and their relationship to the temperature demonstrated the relationship of these values with the Mg-orthotitanate and Mg-zirconate content of the bodies. The dielectric loss of the MgO–TiO_2 bodies is less than 1, probably owing to the exceptional homogeneity of the body structure. The TiO_2–ZrO_2 bodies show small losses, both for high and low frequencies, although they represent mixtures of the two oxides. This is presumably due to the ZrO_2 enclosures in the rutile lattice. Owing to their less homogeneous structures, the bodies in the three-phase system show higher losses than those in the two-phase systems. The dielectric constants of the investigated bodies, particularly those with high TiO_2 contents, are considerably higher than those of the usual ceramic bodies. E.J.V.

Comparative investigations of earthenware glazes. W. Steger. *Ber. deut. keram. Ges.*, **17** [5] 265–77 (1936).—This is a report of the German Ceramic Society Comm. for Study of Chemistry and Physics of Fine Ceramic Bodies and Glazes, whose task was to make a selection of the published earthenware glazes, to study their properties, and to recommend to the industry the best glazes for use. Another problem, equally important, was to study the possibility of selecting, from the multiplicity of glazes, a few basic types showing the best properties for industrial purposes. For the preliminary investigation, twenty-two lead and boric-acid glazes were tested for chemical composition, fusibility determined by the amount of "run" on a sloping plane and by melting in a temperature gradient, fusibility compared with cones, thermal expansion, appearance after firing to cone 7*a* and cone 01*a* to 1*a*, effect on underglaze colors, and lead solubility. These glazes are grouped in a table according to their properties. E.J.V.

Insulators resist rifles. G. M. Whisler. *Elec. World*, **105** [10] 1186–87 (1935).—Breakage by stones and rifle bullets has been minimized by designs which deflect missiles so that they do not exert their full impact force at the point of first contact with the porcelain. Because of weight and leakage distance, the new designs should be used only where breakage is a serious problem. E.H.McC.

Investigations on vitreous china bodies. Edgar Dennınger. *Ber. deut. keram. Ges.*, **17** [4] 165–75 (1936).—To study the effects of different clays and fluxes on the physico-chemical properties of vitreous china bodies, systematic variations were made in the composition of a vitreous china base body containing 50% clay substance, 30% quartz, and 20% feldspar. The fired color was determined mainly by the clays used. The firing shrinkage is dependent mainly upon the amount of flux used, decreasing with increasing amounts of added marble, magnesite, or dolomite. The refractoriness decreased with increasing flux content; it was sufficiently high for practical purposes when up to 5% of the feldspar was replaced by marble, magnesite, or dolomite. The clays exerted the chief influence on the strength in the dry state and the modulus of rupture of the fired body. For practical purposes, it is advantageous to introduce several clays in suitable quantities to obtain sufficiently high values for these two properties. Special importance is attached to the determination of the thermal expansion and stress. Of the bodies examined, those made up with magnesite and dolomite showed a lower thermal expansion and quartz effect than bodies containing only feldspar or than those in which feldspar had been partially replaced by marble. These magnesite and dolomite bodies are less sensitive to irregularities in the firing temperatures and in cooling, so that breakage is less than with bodies containing feldspar or marble. E.J.V.

Manufacture of dinnerware has history, romance behind it. W. H. Locke Anderson. *China, Glass & Lamps*, **56** [1] 43–46 (1936).—The manufacture of dinnerware in a modern factory is briefly described in non-technical language. The steps described include preparation of the clays, forming the ware by jiggering or casting, bisque firing in periodic and tunnel kilns, glaze preparation and application, glost firing, decorating the ware by decals and lining, and a discussion of what constitutes good dinnerware. G.M.P.

Manufacture of porcelain with increased whiteness and

translucence. V. P. ZUBCHANINOV AND Z. I. GLUSHANOK. *Keram. & Steklo*, **12** [7] 24–30 (1936).—The whiteness and translucence of porcelain can be increased (1) by using the purest raw materials, that is, with a minimum content in iron and titanium oxides, and (2) by correct conditions of firing. The capacity to be shaped and the strength of kaolin porcelain bodies after drying is unsatisfactory and can be improved by adding 0.75 to 1.25% of activated bentonite and de-airing the mixes. The addition of organic materials, such as humus, dextrine, etc., improves green strength but not workability. M.V.C.

Pottery manufacture in Queensland. R. C. STONE. *Clay Prod. Jour. Australia*, **3** [12] 7, 11 (1936).—Clays of good quality are abundant in Queensland and procurable at reasonable cost. There is a lack of skilled labor, and the coal situation is not easy. The Bristol Pottery Works (S.'s own company), at Coorparoo, Brisbane, was founded 43 years ago, the city of Brisbane having grown around it. Household ware and toilet ware are made. H.H.S.

Spitting of glazes in the enamel kiln. J. W. MELLOR. *Trans. Ceram. Soc.*, **35** [1] 1–42 (1936).—Much of the spitting of glazes in enamel kilns is due to a biscuit fault, such as the presence of carbonaceous matter or adsorbed moisture in the body, and not primarily to an imperfection in the glaze, which is sometimes explained as an incipient ebullition of dissolved gases or the decomposition of sulfates. On the basis of the carbon theory, spitting in general can be attributed to the development of a momentary high pressure of carbon dioxide in a body still contaminated with carbon after the biscuit firing, produced by the explosive combustion of the carbon particles at high temperatures upon coming into contact with atmospheric oxygen which diffuses through the softened glaze at a red heat. The gases formed force their way through the soft glaze and spit out on the surface. Spitting is not necessarily proportional to the amount of carbon present in the body, but depends on the accessibility of the oxygen to the carbon at the higher temperatures. Glazes are impervious to oven and kiln gases at ordinary temperatures but at high temperatures are known to be permeable to oxygen, hydrogen, carbon monoxide, and various hydrocarbon gases. In the glost oven, spitting, there called pinholing and blistering, occurs only late in the firing at a time when the glaze is no longer fluid enough to repair the damage. Sometimes negative spits are formed when a bubble at the point of bursting cools to the temperature of the glaze and collapses inwardly. Hard glazes and glazes hardened by the solvent action of glaze on body do not tend to spit-out because they are more able to withstand a high internal gas pressure. On the other hand, hard-fired kilns and soft fusible glazes favor spitting, the more fusible the glaze the lower the temperature of spit-out. Hence it can be seen that the longer the initial fusion of a glaze is delayed and the more opportunity is given for a cleanup of the carbon, the less the probability of carbon spitting. The most favorable oxidation period lies in the temperature range 500 to 900°C and more than 50% excess air is required. Spitting is also attributed to the escape of steam from the moisture adsorbed by the body, either as liquid or vapor. A temperature in the vicinity of 450°C is required for the expulsion of all adsorbed water. R.H.H.P., JR.

Substitutes for tin oxide in glazes. R. RIEKE. *Ber. deut. keram. Ges.*, **17** [4] 182–92 (1936).—The various opacifiers used in the enameling industry are briefly discussed, and the difficulties of applying them to pottery glazes are enumerated. It is necessary to adjust the whole composition of the glaze to suit the particular opacifier being used. A complete solution of the problem is arrived at only by a systematic variation of all the glaze components until compositions are found in which the opacifier can exert its best and most powerful influence, without altering the other essential properties of the glaze. E.J.V.

Testing glazes by melting in a temperature gradient and with oblique illumination. W. STEGER. *Ber. deut. keram. Ges.*, **17** [4] 177–82 (1936).—S. describes an electric tube furnace in which the temperature is highest in the middle and falls off uniformly toward the open end, with accurate control of firing and cooling possible. Using this furnace, the effect of varying degrees of firing can be studied on test pieces after a single firing. The furnace is 200 mm. long, the heating tube 30 mm. internal diameter, and the insulating material 300 mm. diameter. In the preliminary experiments, earthenware fritted glazes were fired to 1000° and 1100° in 90 and 100 minutes. The temperature gradient between the middle and end of the furnace was 1100° − 500° = 600°, and 1000° − 450° = 550°. The fired test pieces showed clearly the various stages of firing the glaze, from the unfused, powdery state to complete fusion, and in some cases, overfiring. The glaze surfaces were examined microscopically under oblique illumination in order to bring out differences more distinctly. The apparatus is described and eight photographs of glazed surfaces are reproduced. E.J.V.

Testing porcelain insulators for electric strength. F. OBENHAUS. *Arch. Tech. Messen*, No. 61, pp. T88–89 (1936).—Methods and equipment and measuring instruments for testing with overvoltage, surge voltages, and for puncture tests of various types of porcelain insulators and bushings are described. M.H.

Testing the properties of kaolins and clays with the aid of a standard glaze. F. ALZNER. *Ber. deut. keram. Ges.*, **17** [4] 204–209 (1936).—It is suggested that specifications for clays and kaolins should include a statement of their behavior when glazed and fired with a glaze of definite composition. Two factors of especial importance in the fine ceramic field are the fired color and the tendency to craze. A standard glaze test would be particularly useful when it is necessary to change one raw material in a body for another. Experience has shown that the properties of a material are brought out best when a firing temperature of cone 05*a* is used for the test. A glaze of the following composition for cone 05*a* has been used:

$$\left.\begin{matrix} 0.10\ K_2O \\ .30\ CaO \\ .03\ Na_2O \\ .67\ PbO \end{matrix}\right\} 0.21\ Al_2O_3 \left\{\begin{matrix} 2.41\ SiO_2 \\ \\ 0.33\ B_2O_3 \end{matrix}\right.$$

For use with the Steger glaze-testing apparatus, the glaze must be as free from crazing as possible. Such a glaze, fired to cones 2*a* to 3*a*, is as follows:

$$\left.\begin{matrix}0.13\ K_2O\\ .03\ Na_2O\\ .24\ PbO\\ .60\ CaO\end{matrix}\right\}\ 0.44\ Al_2O_3\ \left\{\begin{matrix}2.44\ SiO_2\\ \\ 0.18\ B_2O_3\end{matrix}\right.$$

Curves showing the different behavior of this glaze on various clays are given. E.J.V.

Vacuum treatment of porcelain mixes. G. K. Tereshchenko. *Keram. & Steklo*, **12** [6] 30–34 (1936).—Experiments showed that (1) the vacuum treatment makes porcelain mixes more plastic; (2) lean mixes can be well shaped; (3) they do not crack on drying; (4) mechanical strength of bodies increases; and (5) the finishing firing of bodies treated in a vacuum is from 1 to 2 firing cones lower than of those treated under ordinary conditions. M.V.C.

PATENTS

Anti-slipping tread and floor covering and method of making. Edward Van der Pyl (Norton Co.). U. S. 2,057,171, Oct. 13, 1936 (Sept. 4, 1934).

Electrical insulator, terminator, bushing, etc. J. C. Rah (Delta-Star Electric Co.). U. S. 2,056,983, Oct. 13, 1936 (Feb. 4, 1932).

Manufacture of lids or covers for pottery articles. Gibson & Sons, Ltd., and G. Mountford. Brit. 454,450, Oct. 14, 1936 (April 18, 1935).

Sanitary apparatus such as wash basins, baths, and closet basins. Établissements Jacob-Delafon Compagnie Céramique de Pouilly-sur-Saône et Belvoye. Brit. 453,469, Sept. 23, 1936 (Oct. 5, 1934).

Self-ventilating toilet. J. A. Friel. U. S. 2,058,436, Oct. 27, 1936 (Dec. 6, 1935).

Thumb rest. J. M. Myer. U. S. 2,057,047, Oct. 13, 1936 (March 11, 1935). A cup having a handle provided with a finger hole is combined with a substantially rectangular rib of a length slightly greater than the vertical extent of the finger hole formed on the cup at one side of the handle and protruding from the cup and having its outer face concaved.

Tile-supporting strip. M. W. Hard. U. S. 2,058,148, Oct. 20, 1936 (Feb. 26, 1934).

Water closet. C. C. Campus. U. S. 2,056,158, Oct. 6, 1936 (Feb. 10, 1936).

Equipment and Apparatus

Adjustable microcomparator. Negretti and Zambra. *Jour. Sci. Instruments*, **13** [8] 269–70 (1936).—The "Synchrisiscope," designed by W. Stirling, provides a rapid method for comparing two objects (objects too large to be included simultaneously in the ordinary microscope field). Separation distance of objects can be varied from 21.5 to 30.5 cm. Working distance of objectives varies from 10.2 to 23.5 cm. The price of the instrument with two pairs of paired objectives, an eyepiece giving magnifications from 3.75× to 10.5×, and a cabinet container is £33 5s. An attachment for color comparison with Tintometer filters with a rack containing 81 red, yellow, and blue filters is priced at £13 6s. Illustrated. J.L.G.

Air-conditioning ruler aids use of psychrometric chart. William Goodman. *Heating, Piping, & Air Conditioning*, **8** [8] 430–31 (1936).—A special transparent rule designed to simplify air-conditioning calculations made with a psychrometric chart is described and illustrated (actual size). J.L.G.

Apparatus and methods for surface testing. F. Pachtner. *Oberflächentech.*, **13** [18] 207–208 (1936).—How surfaces can be tested and the conditions which thereby must be taken into account are briefly discussed. Various optical and mechanical testing methods are described. Eight references. M.H.

Blast-furnace measuring installation of the Georg-Marien-Hütte. S. Hinrichs. *Arch. Tech. Messen*, **5** [60] T78–80 (1936).—Supervision and measuring instrument installation for charges, water, gas, hot-blast, and waste gases of blast furnaces, coke ovens, cement and open-hearth plants, and rolling mills are described in detail. M.H.

Checking combustion conditions. C. C. Downie. *Power & Works Engr.*, **31**, 173–74 (1936).—The present status of methods of measuring combustion efficiency is reviewed, with the conclusion that, although accurate results are obtained, most of the information obtained by the usual methods is superfluous. The best method of determining furnace efficiency is by estimating the percentage of oxygen in the flue gases, and a new apparatus for the purpose, based on exploding the oxygen with hydrogen, is described. The new instrument resembles an Orsat apparatus, with 3-way valves to provide cyclic explosions and with methods of measuring reduction in volume caused by the explosion. An improvised laboratory unit is described in detail and diagrammatically illustrated. F.P.P.

De-airing clay products. M. Ya. Sapozhnikov. *Stroitel. Material.*, No. 2, pp. 11–19 (1936).—A review of the literature and a description of the apparatus are given. P.B. & E.S.

Deposition of air-borne dust. Anon. *Can. Mining Jour.*, **57** [9] 423–24 (1936).—A series of tests made in an airway of a South African mine shows that the condition of the roof and walls in respect to cleanliness and dryness has no effect on the dust content of the air current passing through the airway. G.M.H.

Determination of the granulometric composition of ceramic powders and masses. E. M. Skibina. *Zavodskaya Lab.*, **5** [5] 637–43 (1936).—A vibrating shaking device is described. The shaking continues 10 min.; the direction of movement is horizontal, with 2250 to 2500 vibrations per minute. The screen has a diameter of 15 cm., and 100 g. of matter are taken for a determination. A washer of 2-liter capacity permits washing in 2 min. the plastic components of any ceramic mass amounting to 200 g. Gravimetric determinations of the amount of nonplastic matter can be made by using the Harkort formula for calculations with an accuracy of about 2%. P.B. & E.S.

Dry-press de-airing device. C. E. Curtis. *Jour. Amer. Ceram. Soc.*, **19** [11] 316–17 (1936).

Drying without shrinkage. Czernin. *Tonind. Ztg.*, **60** [55] 677–78 (1936).—The use of a pressure vessel in

which a body or material is dehydrated is discussed. The temperature is raised to the critical temperature of the liquid; the capillary liquid changes immediately into steam without evaporation and is evacuated out of the pressure vessel. M.V.C.

Dust-sampling apparatus. ANON. *Laboratory*, **6** [5] 70–72 (1935).—The apparatus developed by the Fisher Scientific Co. for sampling dust particles and the determination of the number of particles per cubic foot is described and illustrated in detail. F.G.H.

Effect of rate of air circulation on rate of drying. W. L. GREENHILL. *Jour. Australian Council Sci. Ind. Research*, 9 [3] 171–76 (1936).—This is the second of a series of articles on timber-drying kiln aerodynamics. There is a critical drying rate at an air circulation of 120 ft. per min. Above this figure, the drying rate does not increase; below, it drops rapidly. The suggestion is made that this critical limit may be due to change in air-flow from streamline to turbulence. H.H.S.

Elapsed-time register. M. J. STILLMAN CO., INC. *Instruments*, 9 [8] 219 (1936).—The new "Tymeter" is of the single-register type; a five-digit cyclometer registers the total time during which the circuit is closed. It is available in three models, (1) minutes and hundredths, (2) seconds and tenths, (3) seconds and hundredths. A manual switch is provided for subtracting outages. Standard models are for 110 v., 60 cycles, but it can be supplied for other voltages and frequencies. R.W.R.

Electric combustion furnace for the microlaboratory. ANON. *Laboratory*, **7** [4] 60 (1936).—Illustrated. F.G.H.

Electrical determination of moisture content. V. SINCLAIR. *Discovery*, **17**, 220–21 (July, 1936).—In cooperation with the Timber Research Inst. at Berlin, Siemens & Halske have perfected an electrical recorder by which a piece of wood is placed between two plates and the moisture is read off. H.H.S.

Electric treatment of argillaceous earths. J. MUELLER. *Chim. & Ind.*, **36** [2] 440 (1936).—According to a new treatment, argillaceous earths and clay itself can be made solid and consequently more resistant. In treating the earth, two or more metallic electrodes which are connected are inserted. One electrode should be of aluminum, the other of copper or some metal as far removed as possible from aluminum in the chain of electromotive forces. The earth in reach of the current hardens instantly. This solidification is produced mainly by the change of the charge of the particles of clay, brought about by the fall of tension. A clay with many sodium ions at the surface swells and becomes slippery. An acid clay saturated with H and Al ions does not swell. The electric treatment brings about an exchange between the Na ions and the H and Al ions as a result of the decomposition of the water and the dissolution of the aluminum anode. M.V.C.

Electronic apparatus in industry: II. G. WINDRED. *Power & Works Engr.*, **31**, 170–72 (1936).—The applications of the photoelectric cell in industry are described. Illustrated. **III.** *Ibid.*, pp. 226–28.—The theoretical and practical phases of the development and use of the Thyratron or grid-glow tube are discussed. **IV.** *Ibid.*, pp. 266–68.—The grid-controlled mercury arc rectifier is discussed from the standpoint of wave forms and circuits, general construction, and practical applications. For Part **I** see *Ceram. Abs.*, **15** [8] 250 (1936). F.P.P.

Equipment for the dust laboratory. ANON. *Laboratory*, **7** [2] 24–25 (1935).—The Owens jet dust counter is described in detail. Illustrated. F.G.H.

Evolution of gas analysis apparatus. ANON. *Laboratory*, **7** [1] 12–15 (1935).—A brief history of the development of gas-analysis apparatus is given. Illustrated. F.G.H.

Experience in the reduction of hard rocks. W. H. BATES. *Brit. Clayworker*, **45** [534] 216–18 (1936).—B. discusses the crushing and grinding of a quartzite of extreme hardness used in the manufacture of silica brick. The importance of observation of the effect on results, *e.g.*, wear on the pan rolls, size of stone entering the pan, speed of rollers, and pan and moisture content, are pointed out. R.A.H.

Factory experiences in de-airing. T. W. GARVE. *Bull. Amer. Ceram. Soc.*, **15** [10] 335–40 (1936).

Float operated switch. MCDONNELL AND MILLER. *Instruments*, 9 [9] 248 (1936).—This apparatus consists of a mercury switch inside a float which is attached to the head by means of a flexible metallic bellows. As the float switch moves through its arc, the mercury switch makes and breaks contact. The unit can be screwed directly into a tank or vat at any desired height and used as a boiler low-water cut-off, etc. Several models are available. R.W.R.

Fulcrum mechanism for control valves. RUGGLES-KLINGEMANN MFG. CO. *Instruments*, 9 [9] 245 (1936).—This fulcrum mechanism was designed to give proportionality of valve opening for automatic control, without hunting at low loads, as well as smooth "coming-off seat." R.W.R.

Heat-resisting alloy. ANON. *Steel*, **97** [Sept. 2] 41–42 (1935).—A new heat-resisting alloy of chromium-iron-aluminum type, known as Smith No. 10, has been developed by the A. O. Smith Corp. and is used in a new line of heat-treating furnaces for industrial and laboratory use, making available electric heat with metallic resistors for operations to 2400°F. H.E.S.

High-temperature alloys. S. D. WILLIAMS. *National Petroleum News*, **28** [45] 72–74, 76 (1936).—Steel alloys suitable for high-temperature tubing applications are classified according to creep strength, oxidation resistance, and oil-corrosion resistance. R.W.R.

"Homogenisator" for working up plastic bodies. MASCHINENFABRIK PAUL SCHUSTER. *Eng. Progress*, **17** [7] 166–67 (1936).—The raw material, in lump or powdered form, is fed into the hopper of the machine and water is poured over it. The mixture passes between closely spaced crusher rolls into a mixing worm. The vanes of the worm mix and force the material through one or two screen grids. Issuing from the last screen in the form of spaghetti-like strings, the material is passed between finishing rolls which work up any residual granules by rubbing. A second mixing worm then discharges the material as a homogeneous bar. The smallest model for clayworking is designed to work up 2 tons of clay per hour with rolls spaced 2 mm. ($^5/_{32}$ in.) apart. This requires a 12 h.p. electric motor. Illustrated. J.L.G.

Improved dust control appliances. A. KAUFMANN.

Zentr. Gewerbehyg. Unfallverhüt., [N. S.] **13**, 180–82 (Aug., 1936).—Comparative merits of rubber masks and dust-filter masks, for protection of individual workers against dust inhalation, are presented, with two illustrations of each class. In the continuous dust clouds of building and textile trades and for clearing up workrooms filled with steam and dehydrating gases, rubber masks have hitherto been preferable. But where chemical solutions of corrosive dusts prevail in moist air, rubber masks produce intensely irritating skin effects and are being supplanted. Rubber substitutes, such as hardened oils, break down in very alkaline atmospheres into soap products, also injurious to the skin. Filter masks for dangerous dusts (from 2 to 0.2 microns in particle size), adjustable in aluminum frames and weighing as little as 145 g., have been recently improved and tested so as to remove from 60 to 85% of such dusts from the intake of workers. Numerous factors reducible to mathematical estimate enter into such filter construction, *i.e.*, slight breath resistance, small total space, lightest possible nasal pressure and devices to remove perspiration and moisture. Advantageous results secured by Comfo respirators, extensively used in the United States, are given. K. describes his own recently constructed and tested dust-mask filter. K.R.

Industrial thermometers with easy-to-read tubing. Taylor Instrument Co. *Instruments*, **9** [9] 247 (1936).—The new thermometer tubing used in this instrument is provided with a "triple-lens" front, so that the intensity of light concentrated on the mercury column is greatly increased, and the thermometer is easy to read, even from unfavorable angles. R.W.R.

Largest turbo-alternator in Europe. Anon. *Eng. Boiler House Rev.*, **49** [7] 555 (1935).—During September, 1935, a 105,000 kw., three cylinder turbo-alternator set, manufactured by the Metropolitan-Vickers Electrical Co., started operations in the Battersea Power Station. A new record in thermal efficiency for a steam generating station of more than 29% was established, while the coal consumption fell to 0.9067 lb./unit. The turbo-alternator operates with five-stage feed heating and twin condensers, the final feed temperature being 355°F. W.F.F.

Light metals; glucinium. Victor Charrin. *Chim. & Ind.*, **36** [1] 221–25 (1936).—Glucinium in metal form has few uses because of its extreme fragility, but when added to other metals, it improves the mechanical properties. It is used in the glass and refractories industries. Among its different minerals only beryl has been exploited. Though its supply is limited in France, there are rich deposits of beryl pegmatites in Madagascar. M.V.C.

Lithium chloride for air conditioning. F. Russell Bichowsky. *Foote-Prints*, **8** [2] 1–7 (1935).—Air passed over a saturated solution of lithium chloride may be dried within closely controllable limits down to 11% relative humidity. Advantages of lithium chloride over other drying agents are nontoxicity, low freezing point, little corrosive action, stability, no reaction with atmospheric carbon dioxide, relatively low viscosity, absorption of vapors and odorous substances, and coagulation of dust and bacteria. With systems employing lithium chloride, thermal efficiency is high and operating cost low. Applied to industrial drying, the new system provides more uniform quality and drying time, facilitating the use of automatic conveyers in straight-line production. A.P.

Low-temperature alloys. R. K. Hopkins and H. S. Blumberg. *National Petroleum News*, **28** [45] 56–58, 60, 62–63 (1936).—Ordinary carbon steels do not show acceptable impact resistance for temperatures below 0°F, while those deoxidized with silicon and aluminum and showing suitable grain structure can be used down to −60° to −100°F. Electric welding, using a suitable electrode, gives an excellent grain structure in the welded joint. R.W.R.

Machine measures grindability. Anon. *Laboratory*, **7** [3] 44–45 (1935).—The Hardgrove grindability testing machine for determining the grindability of raw materials is described in detail. Illustrated. F.G.H.

Measurement and control of processing temperatures: III. Anon. *Power & Works Engr.*, **31**, 175–80 (1936); *Trade & Eng.*, **38**, 35 (1936).—Automatic temperature control and recording instruments of all kinds are described in detail. Thermoelectric temperature controllers are discussed at considerable length, and the close accuracy of this type of control, even as compared with manual control by a skillful operator provided with accurate indicating, is stressed. For Parts I–II see *Ceram. Abs.*, **15** [8] 251 (1936). F.P.P. + A.B.S.

Mechanical transport in brickworks. J. Procter. *Trans. Ceram. Soc.*, **35** [2] 97–104 (1936).—An endless, overhead chain transporter which lifts and carries a loaded barrow has been developed as a means of transportation, in the brickworks, of the products of the machine to the setter in the kiln. R.H.H.P., Jr.

Method of sieve analysis of kaolins. M. Nikolaev. *Zhur. Resinovoi Prom.*, **10**, 447–49 (1936); abstracted in *Chem. Zentr.*, **ii**, 2201 (1936).—The method is based on the property of the mineral part of kaolin to harden to such an extent that it is not affected by water when calcined at a relatively low temperature. M.V.C.

Moisture content gradients in the drying of clay. Alexis Luikov. *Trans. Ceram. Soc.*, **35** [3] 123–37 (1936).—(*a*) By heating spheres of clay of definite moisture content at various uniform rates in a saturated atmosphere, it was observed that a nonuniform distribution of moisture, approximately proportional to the temperature gradient established, was brought about by thermodiffusion. This moisture gradient can be looked upon as the cause of cracking of a plastic clay when heated in a humid atmosphere. (*b*) Optimum conditions of drying clay can be determined from a knowledge of the maximum allowable moisture gradient, for which a formula is given. R.H.H.P., Jr.

Moisture indicator for wood. M. E. Dunlap. *Instruments*, **9** [10] 282 (1936).—With this instrument developed by the Forest Products Laboratory, a $^1/_8$-in. hole is drilled a little more than $1^1/_8$ in. deep in the wood, and the instrument fitted over the hole. From the underside of the instrument projects a short perforated tube in which is mounted a small piece of goldbeater's skin 0.25 in. by 0.30 in. One end of this element is attached to the tube, the other to a light spring lever, by a fine wire which moves a target up and down as the humidity varies. An indicator is moved manually until contact is made with this target, as indicated by means of a small electric lamp. The mois-

ture content of the wood is read directly from the calibrated scale. This instrument (patent applied for) is not yet in commercial production. R.W.R.

Molten metal temperatures are recorded by Fitterer thermocouple. ANON. *Steel*, **97** [Oct. 14] 52, 57 (1935).—The Fitterer thermocouple is described. The couple comprises an external graphite tube element, within which is a silicon carbide rod. The lower end is placed in the molten metal bath to a depth of about four inches and the upper or cold junction is kept at room temperature by a system of coils through which water is circulated. It is characterized by the fairly large electromotive force which is generated and by the close temperature readings which are possible. H.E.S.

Multiple saturation brick drier. E. KH. ODELSKIĬ. *Stroitel. Material.*, No. 3, pp. 5–7 (1936). P.B. & E.S.

Permeability to gases. Size and structure of the pores in ceramic materials. H. IMMKE. *Keram. Rundschau*, **43** [17] 197–98 (1935).—I. shows the relation between the velocity of gases and form of the capillaries. The general law of flow is $Q = f(\sigma)\frac{p}{\mu \cdot l}$. In this expression, $f(\sigma)$ depends on pore structure. It is impossible to calculate an average value of pore radius from permeability tests. Knowledge of permeability and total porosity allows conclusions concerning pore structure. A practical set-up was invented enabling the rapid measurement of gas permeability. F.E.V.

Photothermometry. K. NENCKY AND P. NEUBERT. *Arch. Tech. Messen*, No. 62, pp. T100–101 (1936).—In photothermometry, for the determination of surface temperatures, the electromagnetic radiation is used which is emitted by the surface and acts on the photographic plates which have been sensitized for infra-red rays. The camera and various kinds of plates available and the calibration and evaluation of the blackened plates are described. The accuracy of this kind of temperature measurement is about ±0.05% while photometric methods give, in the best case, only ±1%. Six references. M.H.

Piping slurry and cement at a modern mill. RALPH H. BUTZ. *Heating, Piping, & Air Conditioning*, **8** [8] 442–43 (1936).—The pumping and piping system used at the plant of the National Portland Cement Co., Brodhead, Pa., is described and illustrated. J.L.G.

Polarization of light and some technical applications. A. F. C. POLLARD. *Nature*, **138** [3486] 311–14 (1936).—The methods of making the "Polaroid" polarizers, invented by E. H. Land, are described. These are used in polarizing microscopes, for projecting lanterns, in ophthalmic apparatus, in antiglare devices, and in photographic processes. Large sheets of polarizing material can be made at a small fraction of the cost for calcite prisms of similar aperture. Transmission and polarization efficiencies for light of different wave-lengths are given (3000 Å to 2.0μ). Values for films and plates, parallel and crossed, are included. J.L.G.

Practical results with vacuum presses. A. C. HEIL. *Tonind.-Ztg.*, **60** [49] 606–607 (1936).—Differences in the structure of ceramic mixes treated by the vacuum method and in the usual way are dealt with. Illustrated. M.V.C.

Production of building brick by dry pressing. S. P. LOGINOV. *Stroitel. Material.*, No. 3, pp. 10–15 (1936). P.B. & E.S.

Progress in the manufacture of instruments for the examination of fine structures by X-rays. A. KARSTEN. *Z. Instrumentenk.*, **56** [3] 120–23 (1936).—Stationary and portable X-ray installations for voltages up to 45 kv. are described. M.H.

Resilient mounting base. BODINE ELECTRIC CO. *Instruments*, **9** [10] 270 (1936).—A new resilient mounting for fractional horse-power motors uses live rubber in shear, which is a much more efficient absorber of vibration than rubber in compression or tension. The mounting is unusually stable. R.W.R.

Resistance alloy operates at 2462°F. C. O. JELLIFF MFG. CORP. *Steel*, **97** [Oct. 7] 33 (1935).—A new electrical resistance alloy known as Kanthal is described as being used up to 2462°F. It may be used without protective gases and possesses remarkable resistance to oxidation. It is particularly free from attack in the presence of sulfur. See also "High—" *Ceram. Abs.*, **15** [1] 35 (1936). H.E.S.

Simple elutriation balance with hand adjustment and automatic recording. M. VENDL AND A. ROMWALTER. *Neues Jahrb. Mineral. Geol.*, **71A** [3] 524–51 (1936).—An elutriation balance constructed according to Odén's principle with a spring balance is described. H.I.

Simplified outfit for photomicrography. EASTMAN KODAK CO. *Instruments*, **9** [8] 218 (1936).—The outfit consists of a camera using $2^1/_4$- x $3^1/_4$-in. roll film and having a fixed-focus lens and a shutter with provision for bulb and time exposures; a light lock to shield the microscope eyepiece and camera lens; a bracket for holding the camera; a support for the camera and bracket, which fastens to the stage of the microscope; and a counterweight that attaches to the microscope base. The microscope is focused in the usual way, the camera is placed over the microscope, and the exposure made. No darkroom is required. R.W.R.

Specific surface of cements and ground rocks. H. ELSNER VON GRONOW. *Tonind.-Ztg.*, **60** [52] 643–46 (1936).—It is shown that by means of distribution curves for grain sizes of cements and rock powders, determined according to the sedimentation methods of Andreasen and Haegermann, Kühl, and Czernin, it is possible to ascertain their specific surfaces. M.V.C.

Spectrographic dispositive of large aperture applicable to the ultra-violet. A. ARNULF AND B. LYOT. *Jour. Phys. Radium* (Suppl.), No. 381, p. 7S (1936).—A spectrograph consisting of a collimator with quartz objective, cornu prism, and a spherical, concave mirror-chamber objective is described. Highly luminous images have been produced using this instrument. F.P.P.

Surmounting difficulties with thermostatic controls. W. S. CROSIER. *Power & Works Engr.*, **31**, 295–96 (1936).—Satisfactory service from automatic thermostatic control equipment is largely dependent on proper installation. The conditions necessary for success include intelligent determination of requirements, correct design of equipment to be controlled, and proper location of the thermostat. Several examples of incorrect installation and the remedies applied in each case are described. F.P.P.

Test sieves. ANON. *Paint Manufacture*, **6**, 222 (July, 1936).—Particle fineness as determined by standard sieves (*cf.* Brit. Stand. Inst. Specif. No. 410/1931) is limited in accuracy to perfectly dry powders. The openings in a 300-mesh sieve measure 53 microns across, while the openings in a 200-mesh sieve measure 76 microns across and the bulk of the particles that pass through may be much finer. It is stressed that a particle is in three dimensions, so that unless it is strictly spherical (which is rare) it may pass a mesh along one dimension and be rejected along another. Irregularity in the wire diameter or distortion of the wire in use may introduce considerable error. A new sieve of 400-mesh (38 microns across) and made of phosphor bronze is now available. H.H.S.

Thermometer principle devised. WESTON ELECTRICAL INSTRUMENT CORP. *Steel*, **97** [Oct. 14] 36, 57 (1935).—A new principle of thermometer construction makes use of a bimetal strip which deflects in proportion to temperature change. The principle involves a unique method of winding the strip into a unit of concentric helical coils, so that the forces of deflection are additive, but the forces tending to cause distortion and friction are mutually counterbalanced within the coils. Using the new form of coil, it is possible to construct rugged all-metal thermometers with an accuracy equal to or exceeding that of the ordinary spirit or mercury type. Several illustrations are also given. H.E.S.

Ton of dust an hour. S. D. MOXLEY. *Factory Management & Maintenance*, **94** [9] 48–49 (1936).—M. explains by means of a diagram and four photographs, each with a long explanatory caption, how an air-cleaning installation in a large foundry cleans 60,000 cu. ft. of air per minute, removing a ton of sand and dust from the air every hour. J.L.G.

Tyndallometer. E. LEITZ, INC. *Instruments*, **9** [9] 247 (1936).—This newly introduced instrument is a portable photometric equipment for determining dust content in air (as in mines or other places where the danger of silicosis exists) by measuring the intensity of the Tyndall beam, a principle said to have been verified by extensive experiments. R.W.R.

Universal microscopic and photomicrographic equipment. E. LEITZ, INC. *Instruments*, **9** [9] 245 (1936).—The new "Panphot" is available for all methods of microscopic investigation, using incident or transmitted light, and the arrangement for transfer from visual observation to photomicrography is convenient. A dark field condenser is also supplied. R.W.R.

Use of temperature-measuring apparatus in metallurgy. EDMUND T. RICHARDS. *Feuerungstechnik*, **24** [81] 41–42 (1936).—R. discusses (1) the limited use of temperature-measuring apparatus in metallurgy, (2) metallurgical processes which do not require the temperature measurement, (3) difficulties of measuring temperature, (4) thermoelectric apparatus, (5) difficulties arising with optical temperature measurements, and (6) various apparatus used to measure temperature. M.V.C.

Vibrating sieves. PIERRE RENAULT. *Rev. Mat. Constr. Trav. Pub.*, No. 320, pp. 78–80B; No. 321, pp. 89–94B (1936); abstracted in *Verre & Silicates Ind.*, **7** [21] 253 (1936).—After examining the principles applied in the construction of the newest types of vibrating drums, R. discusses their interesting applications and the advantages of the process. M.V.C.

Viscosity measurement; rotation viscosimeter. W. PHILIPPOFF. *Arch. Tech. Messen*, **5** [60] T83 (1936).—The principle of the rotation viscosimeter, whereby the torque on a rotating body which attempts to take the liquid along by friction is measured, and several types of instruments are described. The measurement by this principle is independent of the density of the liquid so that the true dynamic viscosity is determined. M.H.

Viscosity of slags. L. P. *Rev. Ind.*, **66** [2323] 230 (1936).—P. describes the Matsukawa apparatus used for viscosity determinations. Experiments are carried out, and the results obtained are commented on. See *Ceram. Abs.*, **13** [5] 133 (1934). R.W.D.

Volume measuring contrivance of grog mixture. ANON. *Tonind.-Ztg.*, **60** [44–45] 557–59 (1936).—Details of an apparatus which determines the granular size of grog mixtures are given. Illustrated. M.V.C.

BOOKS AND BULLETINS

Barrett fusion furnace. ANON. *Burrell Technical Supply Co. Bull.; Ind. Eng. Chem., News Ed.*, **13** [7] 156 (1935).—A furnace designed especially for determining the fusing temperature of coal-ash and other high-temperature work up to 3000°F is described. F.G.H.

British Standard Specification for Testing Mine Fans. British Standards Institution, London. Price 2s. A method, approved by the leading British colliery organizations, for testing the fans used for ventilating coal mines is described and a specimen report is given. A.B.S.

British Standard Specification for Trailing Cables for Mining Purposes. British Standards Institution, London. Price 2s. This specification provides for eight types of trailing cables for use with underground coal-cutters. The mode of construction, sizes of screens, dielectric, cradle centers, sheaths, and mode of making are specified, and a voltage test on the cores and finished cables is described. A.B.S.

Cleaning air with glass. ANON. *Ind. Bull. Arthur D. Little, Inc.*, No. 64 (April, 1932).—The standardized and simplified equipment of a glass-wool filter developed by the Owens-Illinois Glass Co. is described. The advantages of this filter are (1) low cost, (2) low resistance to drafts, (3) high absorption capacity, (4) ease of renewal, and (5) unit construction which permits assembly into large units of desired size. Many applications of the filter are also given. H.E.S.

Electric eye for color. ANON. *Ind. Bull. Arthur D. Little, Inc.*, No. 88 (April, 1934).—Color-measuring instruments using the photoelectric cell have been developed to a stage of practical industrial usefulness, and the analysis, comparison, and matching of colors can now be established on a more exact basis than ever before. H.E.S.

Industrial Filters. A. J. KEISER. No. 6 of Handbuch der Chemisch-technischen Apparate. Otto Spamer Verlag G.m.b.H., Leipzig, 1936. Price 8.50 Rm. Reviewed in *Food Manufacture*, **11** [6] 217 (1936). H.H.S.

Measurement of Temperatures (Measure des Temperatures). GUSTAVE RIBAUD. Librairie Armand Colin. 224 pp. Price unbound, 10.50 F; bound, 12 F. Reviewed

in *Verre & Silicates Ind.*, 7 [25] 302 (1936).—This book will be welcomed by technicians as well as specialists. The chapters treat successively of thermometric scales and markings; gas, steam, and liquid thermometers, metallic resistance apparatus, thermoelectric couples; laws of radiation and optical properties of incandescent bodies; the correction of errors due to conductivity and radiation; the measurement of temperatures of surfaces or flames, and the registering of temperatures. Numerical tables are given. M.V.C.

Permissible electrically operated air compressors. L. C. Ilsley, E. J. Gleim, and H. B. Brunot. *Bur. Mines Rept. of Invest.*, No. 3309. 18 pp. Free. The report describes, in detail, features of air compressors approved by the Bureau of Mines as "permissible." These include the Sullivan Machinery Co. types WK-22, WK-26, and WK-39 compressors, the General Electric Co. types CP-26 D, G, and E compressors, and the Ingersoll-Rand type 20 compressor. R.A.H.

Practical Clayworking. Brown. Clayworker Press. Reviewed in *Brit. Clayworker*, 45 [533] 185 (1936). 235 pp. Price 7s 6d. This book is a treatise on a modern labor-saving plant and equipment and a handbook for the use of all those who handle clay in its various forms and under different complicated treatments. R.A.H.

Pyro-surface pyrometers. Anon. *Pyrometer Instrument Co. Bull.*, No. 60; reviewed in *Ind. Eng. Chem., News Ed.*, 13 [10] 237 (1935). A brief description of an improved type of surface pyrometer which is a self-contained, portable unit adapted for obtaining surface temperatures on curved or flat, stationary or moving surfaces is given. The rugged construction of the pyrometer makes it valuable for heavy-duty work and its construction has been designed to insure long life and a reliable indication of temperatures. F.G.H.

Traylor grinding mills. Anon. *Traylor Engineering and Mfg. Co. Bull.*, No. 1103; reviewed in *Ind. Eng. Chem., News Ed.*, 13 [10] 237 (1935).—A varied line of grinding mills, including tube mills and ball tube and pebble mills, is described, and a number of useful tables on capacities, sizes, and drive are given. Design and construction features of the mills, most of which are intended for large-scale operations and heavy work, are considered in detail. F.G.H.

PATENTS

Air filter. L. L. Dollinger (Staynew Filter Corp.). U. S. 2,058,669, Oct. 27, 1936 (Oct. 26, 1932; March 13, 1935).

Apparatus for concentrating minerals by flotation. Stanley Tucker (Minerals Separation North American Corp.). U. S. 2,054,643, Sept. 15, 1936 (Jan. 21, 1936).

Apparatus for granulating molten materials. W. K. Hall and Frank Heywood (Imperial Chemical Industries, Ltd.). U. S. 2,059,230, Nov. 3, 1936 (Dec. 11, 1930). Apparatus for granulating material by spraying comprises a vessel, a centrally located, conically shaped orifice in the bottom thereof and leading directly to free space, and a rotating propeller-type agitator mounted on a vertical, hollow, rotating shaft forming a conduit adapted to convey gas to the interior of the vessel.

Automatic brick and tile cutter. Davis Brown. U.S. 2,058,663, Oct. 27, 1936 (Oct. 12, 1935).

Clay testing apparatus. D. H. Rowland (Locke Insulator Corp.). U. S. 2,059,036, Oct. 27, 1936 (Dec. 20, 1932). A machine for testing the plasticity of a sample of material comprises axially arranged slidably mounted relatively movable members carrying heads adapted to have the sample interposed between them for compression thereby, a compressible wafer containing fluid under pressure and arranged for compression by longitudinal movement of one of the members, a pressure gage connected with the wafer, there being a check valved passage communicating with the wafer enabling fluid under selected pressure to be introduced within the wafer, a shaft arranged at right angles to the axis of the members and having a crank, a pitman revolubly engaged within the crank and pivotally connected with the other of the members, an electric motor for rotating the shaft, a circuit breaker interposed in the motor circuit, and means operated by rotation of the shaft for breaking the circuit when the shaft has made one complete revolution.

Color comparator. J. W. Forrest and Gustave Fassin (Bausch & Lomb Optical Co.). U. S. 2,054,195, Sept. 15, 1936 (Nov. 2, 1933).

Continuous automatic centrifugal separating machines. American Centrifugal Corp. Brit. 453,651, Sept. 30, 1936 (Feb. 21, 1934). Brit. 453,652, Sept. 30, 1936 (Feb. 28, 1934). Brit. 453,653, Sept. 30, 1936 (March 9, 1934).

Dehydration apparatus. Ludwig Altpeter. U. S. 2,059,191, Nov. 3, 1936 (Nov. 30, 1934). A centrifugal dehydration apparatus comprises a centrifuging drum, means for rotating the drum, a distributor adapted for rotation and for reciprocation along the axis of the drum, means for rotating and reciprocating the distributor and means for feeding the material to be centrifuged to the distributor, a hollow body for draining the liquid from the material to be centrifuged, the hollow body being disposed against the wall of the drum parallel with the axis to extend into the material and presenting an imperforate surface at the forward side, considered in the direction of rotation of the drum, the rear side surface being formed with slots or holes, and outlet means for discharging to the exterior of the drum the liquid passing into the hollow bodies.

Hardness testing machine. Joseph Gogan. U. S. 2,054,197, Sept. 15, 1936 (July 5, 1934).

Method and apparatus for separating solids from fluid suspension. S. C. Lyons (Bird Machine Co.). U. S. 2,057,156, Oct. 13, 1936 (Sept. 20, 1934). Apparatus of the class described comprises in combination a centrifuge, means for progressively delivering a fluid suspension of finely divided solids into the centrifuge, means for progressively removing solids depositing as a layer onto the wall of the centrifuge, means for progressively removing from the centrifuge fluid accumulating inwardly of the layer of solids, and means for impressing the centrifuge wall with an electrical charge tending to attract the solids thereto and for impressing the solids-removing means with an opposite electrical charge, the solids-removing means being electro-insulated from the centrifuge wall, and maintaining the wall at high effectiveness in attracting the suspended solids thereto.

Method of making good thermal contact between metal

and ceramic material. BRITISH THOMSON-HOUSTON CO., LTD., D. GABOR, AND J. A. V. FAIRBROTHER. Brit. 452,507, Sept. 9, 1936 (Jan. 23, 1935).

Method of providing crucibles and tools for use in contact with molten masses with a protective coating. E. H. E. JOHANSSON. Brit. 454,506, Oct. 14, 1936 (April 1, 1935).

Potters' lathes. D. HUMPHERSON. Brit. 453,790, Sept. 30, 1936 (May 1, 1935).

Sectional pipe for use in conveying abrasive materials. N. W. YOUNG. U. S. 2,057,869, Oct. 20, 1936 (Aug. 19, 1935).

Spray gun. H. E. PFAFF, L. R. SHAFFER AND ALEXANDER METHERELL (Tajmal, Ltd.). U. S. 2,054,136. Sept. 15, 1936 (May 6, 1932).

Kilns, Furnaces, Fuels, and Combustion

Airpaths and fans in electrically heated convection furnaces. K. MERTENS. *Elektrowärme*, **6** [10] 290–92 (1936).—Constructive details of heat-treating furnaces for temperatures from 200° to 500°C are described. M.H.

American coal preparation practice. J. B. MORROW. *Mining Congress Jour.*, **22** [10] 44 (1936).—M. reviews recent developments in coal cleaning and drying in the U. S. G.T.

Ash, slag, and slagging. R. FEHLING. *Feuerungstechnik*, **24** [9] 151–55 (1936).—F. discusses (1) the physical and chemical properties of lignite and coal, (2) formation of slag, (3) slagging of the heating surfaces and walls, and (4) ways of eliminating the latter. M.V.C.

Burning coke waste in circular kilns. B. N. GAK. *Stroitel. Material.*, No. 2, pp. 20–31 (1936).—An investigation showed that the introduction of 49% of coke waste into the mixture is effective; it has been introduced in practice and may be increased to 64%. The velocity of the fire and the output of the kiln remain unchanged. The firing régime is improved considerably, and better quality ware is obtained. P.B. & E.S.

Burning problem of gases. ANON. *Laboratory*, **6** [2] 22–24 (1934).—Improvements in many types of laboratory burners are described and illustrated. F.G.H.

Characteristics of Hoffman kilns for firing brick. A. V. YAROSHEVSKIĬ. *Stroitel. Material.*, No. 3, pp. 7–10 (1936). P.B. & E.S.

Circular tunnel kiln. K. HORN. *Allgem. Glas- & Keram. Ind.*, **27** [14] 1–3 (1936).—H. gives a description of two circular tunnel kilns (one being operated in the U.S., the other one in England) used for firing ceramic bodies or for decorating articles by a glazing process. R.W.D.

Colloidal fuel: III. J. L. STREVENS. *Colliery Eng.*, **13** [8] 275 (1936).—Results of several boiler tests of colloidal fuels are briefly reported. Colloidal fuels offer difficulties for use in Diesel engines because of ignition injection and gum formation troubles to which colloidal fuels in which the coal is peptized may be a solution. Processing petroleum residue or tar dispersions of coal by hydrogenation, cracking, etc., has interesting possibilities. Trends in the fuel oil market are discussed. British fuel oil requirements are estimated. For Part I see *Ceram. Abs.*, **15** [8] 252 (1936). G.T.

Combustion chamber design for industrial furnaces. M. H. MAWHINNEY. *Ind. Heating*, **3** [9] 563–66 (1936).—The points to be observed in the design of efficient combustion chambers with respect to temperature, dimensions, and rate of heat liberation are discussed in detail. M.H.

Comparative scheme of the work of a 24-chamber Hoffman kiln by the A. F. Dmitrenko method. A. F. DMITRENKO. *Stroitel. Material.*, No. 5, pp. 9–11 (1936). P.B. & E.S.

Competitive fuels for industrial purposes. A. M. APMANN. *Amer. Gas Jour.*, **142** [1] 15–16, 62 (1935).—Important factors to be considered when figuring comparative costs of fuels are types of heat application, blowers, compressors, temperature control, auxiliary equipment, labor, and the resulting improvement in the quality of the product. A table giving the comparative cost of stereotype melting is included. H.E.S.

Control of coloration of clayware in the tunnel kiln. W. D. RICHARDSON. *Bull. Amer. Ceram. Soc.*, **15** [10] 330–34 (1936).

Density of hydrocarbon gases and vapors. W. B. KAY. *Ind. Eng. Chem.*, **28** [9] 1014–19 (1936).—The P-V-T relations of eleven typical petroleum hydrocarbon mixtures in the gaseous state were determined experimentally over a wide range in temperature and pressure, extending from the saturated condition below to the highly superheated condition above the critical region. The P-V-T data on the mixtures, expressed as deviations from the perfect gas law, are correlated with similar data on pure hydrocarbons by means of the theorem of corresponding states using a particular temperature and pressure for each mixture, termed the "pseudocritical temperature and pressure," for calculating the corresponding reduced quantities. Methods and charts for estimating the pseudocritical temperature and pressure of a petroleum hydrocarbon mixture are given which make possible the calculation of its P-V-T relations over a wide range of temperature and pressure. Illustrated. See *Ceram. Abs.*, **15** [7] 215–16 (1936). F.G.H.

Development of combustion technique. C. P. PARRY. *Fuel Economist*, **11** [128] 291–95 (1936).—The fundamental principles of combustion are reviewed, and their application to boiler maintenance is discussed. Illustrated. F.G.H.

Draft control as a means of fuel conservation in kiln firing. H. R. STRAIGHT. *Jour. Amer. Ceram. Soc.*, **19** [11] 318–21 (1936).

Firing a Belgian kiln. CHARLES HILL. *Brit. Clayworker*, **45** [533] 176 (1936).—This type of kiln is actually a long narrow barrel-arched Hoffman with arrangements for advance firing and with the grate furnaces supplied with primary air. With suitable material, good fuel, and a good induced fan draft, dry goods properly placed in a chamber can be finished in 6 hr. R.A.H.

Flue products of industrial fuels; graphical estimation of dew points. JESSE S. YEAW AND LOUIS SHNIDMAN. *Ind. Eng. Chem.*, **28** [9] 999–1004 (1936).—A series of

curves, based upon the calculated dew point data for the flue products of a number of industrial fuels (solid fuels, fuel oils, and gaseous fuels of as widely varying composition as could be found in the literature) are included on one chart. Illustrated. F.G.H.

Formula for calculating the side-thrust of furnace crowns at furnace temperature. JULIUS LAMORT. Translated in *Glass*, **13** [6] 256 (1936); for abstract see *Ceram. Abs.*, **15** [11] 342 (1936). M.C.S.

Increasing the velocity of fire in a kiln to 18 m. in 24 hr. A. PAVELKIN. *Stroitel. Material.*, No. 3, pp. 3–4 (1936). P.B. & E.S.

Influence of addition of $CaCO_3$ on temperature of fusion of shale ash. V. AREF'EV. *Tzement*, **4** [2] 36–39 (1936).—The addition of $CaCO_3$ (chalk) to the fuel introduced in the kiln in a proportion of about 40% CaO of the total ash content raises the fusing point of the ash and improves the burning process. P.B. & E.S.

Kilns. CHARLES HILL. *Claycraft*, **9** [11] 557 (1936).—H. describes three types of kilns: (1) Hoffman, (2) zigzag, and (3) archless. The Hoffman kiln, to be most successful, must be sufficiently large and have chimneys and flues of capacity great enough to permit efficient combustion and proper heat distribution and transfer. A fan-operated kiln gives superior results in every respect. The zigzag type kiln differs from the Hoffman kiln in that it has long, narrow chambers, the fire traveling through the inside of one chamber and on the outside of the next, and it requires mechanical draft. A well-designed kiln of this type is independent of the atmosphere and has almost unlimited productivity and adaptability. Archless kilns are of two types, those with a permanent partition wall and those in which the partitions are built up of green brick. M.C.S.

Natural gas; conversion to carbon monoxide and hydrogen. W. A. KARZHAVIN. *Ind. Eng. Chem.*, **28** [9] 1042–44 (1936).—The process of converting natural gas with steam to produce carbon monoxide and hydrogen is tested on a semi-industrial scale. Illustrated. F.G.H.

Null-method photoelectric reflectometer. RICHARD S. HUNTER. Presented at meeting of Amer. Ceram. Soc., Columbus, Ohio, March 29–April 4, 1936; abstracted in *Enamelist*, **13** [8] 22 (1936). E.J.V.

Oil firing in the ceramic industry. ERNST KEMPE. *Tonind.-Ztg.*, **60** [55] 682–83 (1936).—A general discussion of the advantages and disadvantages of oil firing in the ceramic industry is given. M.V.C.

Recent developments in ceramic firing. L. BULLIN. *Trans. Ceram. Soc.*, **35** [2] 53–96 (1936).—The lines along which progress has been made in the art of firing ceramic ware since the industrial depression are indicated by a detailed description of the construction and operation of periodic, tunnel, and tubular kilns, the development of automatic temperature control equipment, the installation of gas producers for ceramic firing, and possible future developments in the industry. A table of firing and fuel data from a representative selection of tunnel kilns built in America and Europe is appended. Illustrated. R.H.H.P., JR.

Recuperators for industrial furnaces. W. TRINKS. *Ind. Heating*, **3** [10] 637–38 (1936).—The economic importance of recuperators in conjunction with industrial furnaces is discussed, and suggestions are offered regarding locations and furnace equipment to derive maximum benefits from their installation. M.H.

Results obtained in a Lenox walking-beam kiln. LEONARD S. BRIGGS. *Bull. Amer. Ceram. Soc.*, **15** [10] 373–74 (1936).

Review of data on combustion in kilns. W. E. RICE. *Bull. Amer. Ceram. Soc.*, **15** [10] 325–30 (1936).

Silica gels and other dehydrating agents. J. CAILLAUD AND J. BEAUFILS. *Chim. & Ind.*, **35** [6] 1280–92 (1936).—Testing methods based on articles by P. Demougin ("Absorption of gas and vapor by active carbon and silica gels," *Mem. Poudres*, **25**, 18 (1932), and "Phenomena of hygroscopicity," *Chim. & Ind.*, **34** [3] 517 (1935)) were perfected by the authors. Taking silica gel as an example, they show how to measure those properties (hygroscopic) which enter into the question of drying and their use in practice. Suggestions on applying these methods to other dehydrating agents are made. M.V.C.

Smoke abatement, with special reference to intermittent kiln firing. N. STEELE GRAY. *Claycraft*, **9** [10] 477 (1936).—G. reviews the causes of excessive smoking which results in heat losses in ceramic kilns. Methods of overcoming this condition are described; through the proper introduction of primary and secondary air to the combustion chamber an effective elimination of smoke can be effected. This also (1) reduces fuel consumption, (2) improves control and temperature distribution, (3) permits the use of cheaper fuel, and (4) reduces labor costs. M.C.S.

Smoke question: II. ANON. *Brit. Clayworker*, **45** [533] 171–73 (1936).—The desirability of England adopting the Ringelmann Smoke Chart in its campaign of smoke abatement is pointed out. The presence or absence of smoke in various types of downdraft and tunnel kilns is discussed together with the desirability of a long firing zone in the latter type of kiln and induced draft, rapid burning, incandescence in advance of fuel feed, and automatic firing for both types. For Part I see *Ceram. Abs.*, **15** [11] 343 (1936). R.A.H.

Smokeless fuel. C. P. FINN. *Coal Carbonization*, **2** [7] 137 (1936).—A discussion of the Koppers Carbolux and Lecocq medium temperature carbonizing systems is presented. G.T.

Tunnel kilns. E. P. TAUDEVIN. *Claycraft*, **9** [10] 447 (1936).—A general description of tunnel kiln operations is presented. M.C.S.

BOOKS AND BULLETINS

Analytical Methods for the Examination of Coke-Oven Gas (Analytische Methoden für die Untersuchung von Kokereigas). 2d ed. Published by Ruhrgas A.-G., Essen, Germany. 52 pp., 14 illustrations. Reviewed in *Ind. Eng. Chem., News Ed.*, **13** [17] 361 (1935). F.G.H.

Annual Report of the Fuel Research Board for 1935. DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH. Published by H. M. Stationery Office, London, 1935. 188 pp. Price 3s 6d. Reviewed in *Engineering*, **140** [3647] 611–12 (1935). H.E.S.

Coal and Men; an Economic and Social Study of the British and American Coalfields. HAROLD M. WATKINS.

George Allen and Unwin, London, 1934. 460 pp. Price 18s. Reviewed in *Geographical Jour.*, **85** [2] 200–201 (1935). F.G.H.

Feldspar industry in 1935. ANON. *Bur. Mines-Mineral Market Rept.*, MMS 477. 3 pp. Free. An advance summary is given. R.A.H.

In and under Britain; the Story of Coal. M. H. HADDOCK. Crosby Lockwood and Son, London, 1934. 252 pp. Price 6s 6d. Reviewed in *Geographical Jour.*, **85** [3] 277 (1935).—The formation of coal, the methods of mining, and its utilization as fuel are described. F.G.H.

Oxidation and loss of weight of clay bodies during firing. WM. M. MORGAN. *Univ. of Ill. Bull.*, **33** [46] 40 pp. (1936).—An exhaustive study was made to determine the temperature intervals in which the loss of weight occurred most rapidly and to correlate loss of weight, loss of water, and the oxidation phenomena during firing of clay bodies. The loss of water depends largely on the rate of heating rather than on the actual temperature. Between 825° and 1200°F, water was given off rapidly, the maximum rate occurring at about 1050°F. CO_2 began to be evolved at as low as 425°F, and was removed rapidly from 700° to 950°F with a maximum at 825°. SO_2 was given off at 425° and continued up to 1800°F, the maximum being at 950°F. If the clay contains C, additional losses occur from 400° to 1400° with a maximum at about 825°. S without C will be half removed between 750° and 950°F. Oxidation depends chiefly upon the nature and relative amount of C and S compounds present and, to a lesser extent, upon the vitrification characteristics of the clay; it is also influenced by shrinkage and decrease in size of the pores which reduces the permeability and, therefore, may retard and stop oxidation. In general, clays increase in porosity with increased firing temperatures, reaching a maximum at about 800° to 1200°F for plastic fire clays and 1200° to 1600°F for shales. The conditions for various materials are illustrated by curves, and tests are described in full. 78 references. M.H.

PATENTS

Heating furnace. P. S. MENOUGH. U. S. 2,056,070, Sept. 29, 1936 (Nov. 15, 1933). In a continuous heating furnace, a furnace bottom structure comprises a series of spaced longitudinally extending sections formed of refractory material, and a second series of spaced longitudinally extending sections, means for reciprocating one of the series of sections in a longitudinally extending direction through the furnace, the other of the series of sections being adapted to support the material passing through the furnace during the rearward stroke of the reciprocable sections, and a plurality of transversely extending material engaging fingers mounted on at least one of the sections.

Pottery kilns. J. G. MCKEAN AND R. F. JONES. Brit. 453,304, Sept. 23, 1936 (July 15, 1935).

Walking beam furnace. CARROLL CONE (Surface Combustion Corp.). U. S. 2,057,367, Oct. 13, 1936 (April 25, 1936).

Geology

Association of the formation of kaolin and alumina from granite and gneiss. F. W. FREISE. *Chem. Erde*, **10** [3] 311–42 (1936).—From observation in the Brazilian granite-gneiss areas it is concluded that the action of H_2CO_3 on granite gneiss leads to the formation of kaolin, while the action of humus acids tends to produce alumina-silica gel mixtures. Other organic acids, particularly formic acid and lactic acid, are important in the formation of rock decomposition products. Such products, after formation, are frequently subject to chemical and physical actions, producing quite different rocks. H.I.

Bentonite. ANON. *Can. Mining Jour.*, **57** [9] 417 (1936).—Bentonite is being used by the U. S. Forest Service to prevent water seepage. It is suggested that, in the form of slurry, it might be used to seal underground water flows in mines. G.M.H.

Bentonite, a new Italian mineral. G. SISSA. *Metallurgia Ital.*, **28**, 232 (1936); abstracted in *Chem. Zentr.*, ii, 1991 (1936).—Large deposits of high-grade bentonite were discovered on Ponza island (Pontin). The uses of bentonite are discussed. M.V.C.

Chalcostibite-emplectite; concordance in dimension of the elementary cell and crystallographic parameters. M. H. UNGEMACH. *Bull. Soc. Franç. Minéral.*, **57** [3–6] 186–207 (1934). H.I.

Chemistry of fuller's earth. ADOLF VOIGT. *Fettchem. Umschau*, **43**, 49–52 (1936); abstracted in *Chem. Zentr.*, ii, 1991 (1936).—Fuller's earth is composed chiefly of montmorillonite crystals, and exchangeable Ca and Mg ions are present in them. The activation of fuller's earth is based on the exchange of Ca-Mg ions by H ions. M.V.C.

Clay in soil corrosion. C. ACLAND. *Jour. Australian Chem. Inst.*, **3** [8] 229 (1936).—Clay soils found in Sydney, being more retentive of moisture, are more corrosive to underground metallic structures than sandy soils where natural drainage facilities are good. The mechanism of corrosion is as follows: (1) the setting up of galvanic potentials by differential aëration and by the action between oxide scale and bare metal, and (2) the electrical resistance of the soil. H.H.S.

Clays of Danish brickworks. A. O. *Lerindustrien*, No. 14, pp. 95–97; No. 15, pp. 98–101; No. 16, pp. 104–106 (1935); abstracted in *Tonind.-Ztg.*, **60** [30–31] 402 (1936).—The origin, composition, and properties of clays used in Denmark are discussed. M.V.C.

Comparative investigations on natural and synthetic emerald crystals. E. SCHIEBOLD. *Z. Krist.*, **92**, 435–67 (1935).—Chemical, crystallographic, optical, and X-ray investigations of synthetic emeralds produced by the I. G. Farbenindustrie show that they are closely related in all respects to the natural gem. H.I.

Core drilling: I. G. A. ROBINSON. *Mining Mag.*, **55**, 73–80 (1936).—Core drilling gives comparatively accurate results, but has limitations. It is not much use in formations with patchy values. The hole often deviates from the direction laid out. This is due to variation in hardness of the formations and incorrect handling. Abrasives used are black or white diamonds or tungsten carbide. These

have to be set with great care. Black diamonds are best but the most expensive. In soft or broken rock it is frequently impossible to recover all the core, and these places are often the most significant. II. *Ibid.*, pp. 153–58.—Labor costs are the greatest expense in core drilling. Much depends on the efficiency, ability, and honesty of the foreman. Complete costs, detailed reports of progress, and a complete record of the hole, the cores, and any assays are necessary. W.D.F.

Crystal structure of hydrargillite, $Al(OH)_3$. H. D. MEGAW. *Z. Krist.*, **87**, 185–204 (1934).—The structure of hydrargillite (gibbsite) as determined from Weissenberg photographs shows that the substance is monoclinic with the cell dimensions, $a = 8.6236$, $b = 5.0602$, $c = 9.699$, $\beta = 85° 26'$. There are 8 mols. per unit cell. The structure is a pseudohexagonal layer lattice, each layer consisting of two planes of approximately close-packed oxygens enclosing a layer of aluminums. The aluminums are distributed in a regular hexagonal arrangement to occupy two out of three possible close-packed positions. H.I.

Crystals having optical anomalies. R. HOCART. *Bull. Soc. Franç. Minéral.*, **57** [1–2] 5–127 (1934).—Minerals which geometrically appear to belong to systems with high symmetry are shown by optical and X-ray studies to possess lower symmetry, the pseudosymmetry having been produced by twinning. The minerals boleite, boracite, pharmacosiderite, senarmontite, and apophyllite were studied in detail and shown to possess such pseudosymmetry. H.I.

Crystallographic data, unit cell, and space group for berthierite ($FeSb_2S_4$). M. J. BUERGER. *Amer. Mineralogist*, **21** [7] 442–48 (1936).—Crystallographic data are lacking for berthierite because its imperfect morphological development prevents optical goniometric study. The data of B. have been easily obtained by Weissenberg methods. Although an intensity-parameter study has not been made, a structure is suggested based upon a substituted sphalerite-type framework. F.J.Z.

Definition of the sepiolites. G. MIGEON. *Bull. Soc. Franç. Minéral.*, **59** [1–2] 6–134 (1936).—By X-ray, heating curve, and dilatometric studies the formula for sepiolite, $Si_4O_{11}(Mg{\cdot}H_2)_3{\cdot}1H_2O(H_2O)_x$ proposed by Longchambon (see *Ceram. Abs.*, **14** [9] 231 (1935)) is confirmed. $(H_2O)_x$ represents the zeolitic water removed below 350°C by slow heating, often being integrally re-absorbed on cooling or replaced by other substances absorbed as vapor. The group $Si_4O_{11}(Mg{\cdot}H_2)_3{\cdot}H_2O$ represents a hydrate which begins to decompose at 320 to 350°C, its decomposition resulting in (1) rapid loss of H_2O between 370° and 550°, (2) rapid contraction between 320° and 420°, and (3) modification of the crystal lattice only after almost complete transformation of the mineral (first visible at 400° with slow heating). Natural sepiolite is called sepiolite I, and the sepiolite obtained by decomposition of the hydrate, sepiolite II. Complete destruction of the mineral at temperatures above 750° results in the formation of the X-ray pattern of enstatite. H.I.

Determination of the refractive indices of minerals by the immersion method. CHESTER B. SLAWSON AND A. B. PECK. *Amer. Mineralogist*, **21** [8] 523–28 (1936).—There is an infinite number of possible orientations available for the determination of each of the principal indices of refraction; a routine procedure is not always desirable because experience points the way to "short-cuts." Usually the errors involved in the method described are smaller than the known variations of the indices within a mineral species. F.J.Z.

Diatomite (kieselguhr). A. POULSEN. *Ingenioren*, No. 14, pp. 59–60 (1936); abstracted in *Tonind.-Ztg.*, **60** [49] 615 (1936).—The industrial uses of diatomite, including its recent use as an absorbing medium for vitamin B, are dealt with. M.V.C.

Dickite from St. Louis County, Missouri. VICTOR T. ALLEN. *Amer. Mineralogist*, **21** [7] 457–59 (1936).—A sample of St. Louis County clay in the collection of geodes in the museum of St. Louis Univ. contains dickite and is evidence that hydrothermal solutions reached east central Mo. during post-Mississippian time. F.J.Z.

Discovery of Dr. Veatch. ANON. *Amer. Enameler*, **9** [5] 10 (Sept., 1936).—The development of the borax industry in the U. S., an industry which plays such an important part in the manufacture of enamel, glass, etc., is presented. J.H.S.

Elastic properties of rocks; a correlation of theory and experiment. JOHN M. IDE. *Proc. Nat. Acad. Sci.*, **22** [8] 482–96 (1936).—Dynamic measurements of the modulus of rigidity of rocks are computed from the torsional resonance frequencies of cylindrical samples. Dynamic measurements of Poisson's ratio obtained from the deviation of the longitudinal harmonic frequencies from integral multiples of the fundamental are found to agree with values computed from Young's modulus and the modulus of rigidity. Relations between elastic constants determined in the laboratory and the theoretical formulas which express the connections between the constants of a perfect elastic medium, are discussed in detail. Formulas, tables, and graphs are included. J.L.G.

Ettringite from Scawt Hill, Co. Antrim. F. A. BANNISTER. *Mineralog. Mag.*, **24** [153] 324–29 (1936).—The refractive indices for natural crystals of ettringite are given: $\omega = 1.4655$, $\epsilon = 1.4618$ (for Na light). Based on X-ray and chemical data, a zeolitic type of structure is proposed with the formula $Ca_{12}Al_4(OH)_{24}(SO_4)_6{\cdot}52H_2O$. H.I.

Geochemical studies at Göttingen; distribution of metals in nature. V. M. GOLDSCHMIDT. *Tek. Ukeblad*, **83**, 124–28 (1936); abstracted in *Chem. Zentr.*, **ii**, 449 (1936). M.V.C.

Geochemistry of lithium. LESTER W. STROCK. *Nachr. Ges. Wiss. Göttingen. Math.-physik. Klasse* [Fachgr. 4] No. 1, pp. 171–204 (1936); abstracted in *Chem. Zentr.*, **i**, 4409–10 (1936).—One hundred ninety analyses were performed. Rock mixtures of separate rocks and minerals studied include the gabro-basalt family, syenite-trachite family, granite-liparite, zeolites, nepheline-syenite-phonolite, dioxite-andesite family, meteorites, sedimentary rocks (clay and iron oxide sediments, sandstones, limestones, sea salt), ashes of plants, coal, and other minerals and rocks. The results are tabulated. M.V.C.

Geologic age of potash deposits. RALPH L. RUTHERFORD. *Bull. Geol. Soc. Amer.*, **47** [8] 1207–16 (1936).—The thesis is advanced that in pre-Carboniferous time the seas were relatively poorer in potash than in subsequent periods and that the first notable increase in potash was due to the growth and decomposition of much plant material

accumulated in Carboniferous time. If true, search for potash in older formations is futile. R. discusses the ratio of potash to soda in rocks and in sea water and variations in ratio. A.C.B.

Geological foundations of soils of India. D. N. WADIA, M. S. KRISHNAN, AND P. N. MUKHERJEE. *Rec. Geol. Surv. India*, **68** [4] 364–91 (1935).—Two maps are given, one showing the more important rock formations upon which soils are founded and the other showing approximately the distribution of the more important and special types of soils in India. Bibliography. A.P.S.

Hydrothermal alteration of montmorillonite to feldspar at temperatures from 245° to 300°C. JOHN W. GRUNER. *Amer. Mineralogist*, **21** [8] 511–15 (1936).—Montmorillonite was heated in aqueous solutions of $KHCO_3$ in gold-lined pressure bombs. Seven days at 300°C produced good orthoclase. The X-ray powder photograph is easily identified as that of adularia. At 272°C the feldspar pattern became distinct after 10 days. At 245°C six weeks to three months were necessary to produce the orthoclase structure. Six weeks at 200°C, on the other hand, had no apparent effect on montmorillonite. Potassium chloride solution (10%) does not seem to attack montmorillonite at 300°C in 19 days. Muscovite, which by reason of its structural similarity could have been expected to form from montmorillonite, failed to appear in any of the experiments. While it is highly probable that orthoclase may form at temperatures below 245°C, it is impossible to make an estimate as to the lowest temperature of formation. The finding of authigenic feldspars in sedimentary rocks seems to indicate temperatures at least as low as 100°C. F.J.Z.

Igneous rock names and their evaluation. JOHN C. HAFF. *Amer. Mineralogist*, **21** [7] 427–41 (1936).—H. feels that it is beyond the capability of the individual to reconcile the confused usages indicated in the paper with better usage, but suggests that comparisons be made with those more substantial types of rock names mentioned. Practical application, precedent, individual preference, and varying concepts of rock derivation are all involved in the proposal of a rock name. A successful nomenclature will probably be binomial in character and will thereby bring together the petrographic and magmatic attributes of rocks. F.J.Z.

Industrial uses of dolomite. G. V. *Ind. chimique*, **23** [269] 410–11 (1936). R.W.D.

Italian diatomaceous earth. FERRUCCIO PALAZZI. *Centro Studi Ceram.*, **3** [1] 10 (1936).—The results of researches on the shrinkage, porosity, apparent density, and resistance to pressure are given. M.V.C.

Kieselguhr, the oldest and best known insulating material. CARL PHILIPPI. *Wärme- & Kälte-Tech.*, **38** [6] 4–7 (1936); abstracted in *Chem. Zentr.*, **ii**, 1599 (1936).—A brief review of the use of diatomite is given, and its properties are discussed. M.V.C.

Magnesium aluminosilicate minerals in Western Australia. E. S. SIMPSON. *Jour. Roy. Soc. W. Australia*, **20**, 54–56 (1934).—Gigantolite, a pseudomorph of cordierite ($Mg_2Al_4Si_5O_{18}$), has been found at Melville, Mur, W. Australia, and garnets of spessartite occur in the gigantolite. H.H.S.

Mineral constitution of various ceramic clays. R. E. GRIM AND R. H. BRAY. *Jour. Amer. Ceram. Soc.*, **19** [11] 307–15 (1936).

Mineral determination by microchemical methods. LLOYD W. STAPLES. *Amer. Mineralogist*, **21** [10] 613–34 (1936).—Microchemical methods for the determination of nonopaque minerals have not received the attention which they deserve. These methods frequently result in a saving of time, labor, and reagents. A comparatively few reagents, most of which are inexpensive and available in blowpipe laboratories, satisfactorily meet most determinative problems. If only small amounts of minerals are available for testing, or in the case of minerals with high indices of refraction, microchemical methods are very valuable. They will probably be most efficient in supplementing the study of minerals in crushed fragments by the immersion method. Microchemical determinative methods are not without difficulties. These may be due to poor technique, difficult solubility of minerals, lack of good tests for certain elements, etc. In spite of these difficulties, the advantages gained from these methods are sufficient to recommend them strongly. Several new, simplified, or improved tests are discussed. Aluminum, iron, and manganese may be detected by ammonium paramolybdate, and the fluosilicate test developed by Boricky and Behrens has been improved so that it provides a simple and adequate test for silicon. Crystalline precipitates are preferred to color reactions for most work. The technique of microchemical testing is very important, and suggestions regarding improvements and simplification of it are made. F.J.Z.

Mineralogy of fine-sand fractions of soils. DOROTHY CARROLL. *Jour. Roy. Soc. W. Australia*, **20**, 71–102 (1934).—The formation of new minerals such as kaolinite within a soil acts as a guide to the chemical history of the soil. The fine-sand fractions of soils from Australia, Tasmania, the East Indies, and Japan were examined for their mineral content. The results are tabulated in percentage of frequency of occurrence. Note is made of the color of the soil and the minerals which cause it. H.H.S.

Modification of some colloidal properties of Italian kaolin. F. DE CARLI AND U. PASSARINI. *Ricerca Scientifica*, **2** [3–4] 145–53 (Aug., 1936).—After discussing the causes which determine differences in the colloidal properties in kaolins having practically the same kaolinite content, the authors describe their method of artificially increasing the plasticity of rocky kaolins of Italy, making them equal to or superior to English kaolins. M.V.C.

Observations on orthoclase twinning according to Karlsbad law. H. TERTSCH. *Zentr. Mineral. Geol. A*, No. 7, pp. 198–206 (1936). H.I.

Occurrence of dumortierite in the Eulengebirge, Silesia. G. FISCHER. *Zentr. Mineral. Geol. A*, No. 4, pp. 123–24 (1936). H.I.

Optical and X-ray identification of kaolinite, halloysite, and montmorillonite. C. W. CORRENS AND M. MEHMEL. *Z. Krist.*, **94** [5] 337–47 (1936).—There is a marked relation between index of refraction and water content in halloysite and montmorillonite. For three samples of montmorillonite investigated, there is a linear relation between MgO content and the index of refraction. The introduction of molecules of immersion medium into the structure

of the montmorillonite also affects the index of refraction. Details of technique in the microscopic determination of these three minerals in sediments are given. X-ray investigations show that all three minerals belong to the group of layer-lattice silicate structures with tetrahedral bonds of pseudohexagonal type. They are very similar in their powder diffraction patterns, the principal differences appearing in the lines nearest the zero beam and providing a basis for distinction. H.I.

Optics and structure of three-dimensional spherulites. H. W. Morse and J. D. H. Donnay. *Amer. Mineralogist*, **21** [7] 391–426 (1936).—The shape and optical characters of artificial spherulites and related aggregates were studied to help elucidate their internal structure. Although these aggregates vary widely in external shape, most belong to the same type of "aggregation," due to radiating crystallization. Observation of possible transitional stages leads to a working hypothesis as to the mechanism of formation of spherulitic structures, *viz.*, that a continuous branching out of the fibers makes an aggregate appear like a sheaf of fibers opening at both ends, in fan-like manner, as growth proceeds until spherical shape is reached or approximated. The optical unit of the structure is the fiber, which behaves like a uniaxial entity. The refractive indices of the fiber, however, differ from those of the crystalline species that builds up the fiber. Various factors are considered in an attempt to explain this discrepancy: (1) crystal orientation along the fiber, (2) presence of a less refracting interstitial medium, and (3) form-birefringence, in case the constituents of the fiber are smaller than the wave-length of light. The circular outline of spherulites immersed in certain media appears elliptically distorted. This optical effect, previously observed by Spangenberg, may give information on the fiber indices but not on the indices of the crystals constituting the fiber. Some of the authors' preparations show the artificial duplication of the "supplemental growth" found by Cross in natural spherulites. F.J.Z.

Paleozoic pegmatites in the Pennsylvania highlands. Donald M. Fraser. *Amer. Mineralogist*, **21** [10] 662–66 (1936).—Quartz-feldspar dikes have been found in the Hardyston sandstone of Cambrian age where it directly overlies the pre-Cambrian rocks in the Pennsylvania highlands. The occurrence is in the east end of Morgan Hill along the Delaware River, in the eastern part of Northampton County where the roughly parallel ridges of the Highland area strike nearly east and west. The quartz-feldspar introduced material occurs in the lower few feet of the sandstone in groups of small lenticular dikes only a few feet long and usually not more than a few inches thick. Microcline and apatite were formed first and were later invaded by an abundance of quartz which has replaced the feldspar to a large extent. The pegmatitic invasion of Lower Paleozoic rocks has long been recognized in the Philadelphia area but F. does not know of its being previously reported in the Pennsylvania highlands. With the finding of definite pegmatitic material of Paleozoic age, it may be reasonably assumed that much of the silicification of Paleozoic rocks of the area has been accomplished by magmatic solutions; it is also likely that at least some of the quartz veins in these rocks were formed from solutions of magmatic origin which, in their less aqueous and more siliceous phases, formed pegmatites. F.J.Z.

Palygorskite and other clay minerals. E. S. Simpson. *Jour. Roy. Soc. W. Australia*, **20**, 56–59 (1934).—Palygorskite, a clay mineral co-crystalline with halloysite, has been found for the first time in Australia at Dartmoor, W. Australia. The end members of the isomorphous series are assumed to be halloysite ($H_4Al_2Si_2O_9 \cdot 2H_2O$) and a hypothetical mineral, picrocollite ($H_4MgSi_2O_9 \cdot 2H_2O$); the constitutions suggested are alpha palygorskite = Hal + Pic, beta palygorskite = Hal + 2 Pic, Wadara pilolite = Hal + 3Pic, alpha pilolite = Hal + 4 Pic (for pilolite see *ibid.*, **14**, 52 (1928)). H.H.S.

Petrified wood of Egyptian desert. Ernst Stromer Von Reichenbach. *Chem.-Ztg.*, **59** [64] 657 (1935).—Chemical and petrographic studies showed that petrified wood is composed of 88 to 97% SiO_2 and a small percentage of Fe and Al. There is no water, and organic substances are reduced to less than 1%. The cell walls are partly destroyed or well permeated with quartz, although containing organic substances. The penetration of SiO_2 into the trunks imbedded in sand is due to a noncolloidal monosilicate which, according to the newest studies, is stable in a definite acid concentrate. M.V.C.

Podsols and brown forest soils: II. Karl Lundblad. *Soil Sci.*, **41** [4] 295–313 (1936).—Methods for determining the amphoteric properties of the soil colloids were studied. Base exchange, cataphoresis, ultimate p_H, exchange neutrality, and combining capacity give reliable information about the soil forming processes and more or less accurate distinctions between the soil types investigated. G.R.S.

Possible age of monazite from Mars Hill, N.C. John Putnam Marble. *Amer. Mineralogist*, **21** [7] 456–57 (1936). F.J.Z.

Practical applications of X-rays for the examination of materials. W. G. Burgers. *Phillips Tech. Rev.*, **1** [5] 158 (1936).—The X-ray defraction patterns of aluminum oxide and several other compounds are given. The pictures are used to identify material to determine its crystal structure. H.K.R.

Preparation of oriented polished sections of small single crystals. M. J. Buerger and J. S. Lukesh. *Amer. Mineralogist*, **21** [10] 667–69 (1936).—The apparatus and procedure for grinding and polishing oriented sections of small crystals are described in detail. F.J.Z.

Products of hydrothermal reactions on clayey substances: VI. S. Nagai. *Jour. Soc. Chem. Ind. Japan*, **39** [8] 252–54B (1936).—The results of further researches on the hydrothermal reactions of sodium hydroxide solution on various clayey samples of high silica content are summarized and tabulated. For Parts **II–V** see *Ceram. Abs.*, **15** [10] 315 (1936). M.V.C.

Quarrying quartzite. Anon. *Excavating Engr.*, **30** 518–21, 530–34 (1936).—This deposit in Wisconsin has unknown depth, an extremely rough surface, and many seams. At first blasting was done by drilling 6-in. holes 15 ft. apart, but drilling time was saved and explosives were more easily loaded by drilling 9-in. holes 22 ft. apart. Much oversize is produced, which is largely broken up by a crane with a 5000-lb. "skull cracker," reducing the secondary blasting to a minimum. W.D.F.

Rapid microscopic method for distinguishing quartz

from untwinned oligoclase-andesine. THEODORE A. DODGE. *Amer. Mineralogist*, **21** [8] 531–32 (1936). F.J.Z.

Sepiolites. H. LONGCHAMBON AND GEO. MIGEON. *Compt. Rend.*, **203** [7] 431–33 (1936).—Three new kinds of sepiolites of high crystallinity and purity have been found; their compositions were determined to $Si_4O_{11}Mg_{2.66}H_{0.4}\cdot 1H_2O\cdot(H_2O)_{3.4}$, $Si_4O_{11}Mg_{2.7}H_{0.6}\cdot 1H_2O\cdot(H_2O)_{3.5}$, and $Si_4O_{11}Mg_{2.75}H_{0.5}\cdot 1H_2O\cdot(H_2O)_{3.5}$. Structural differences are described. M.H.

Sodium silicate and the purification of kaolins. ALBERT DEBECQ. *Verre & Silicates Ind.*, **7** [24] 285 (1936).—A much better separation of kaolin from sand and other impurities is obtained by electroösmosis than by ordinary washing. As electrolyte, a dilution to 38/40° Bé of neutral sodium silicate in the proportion of 1% of the weight of the material treated is used. M.V.C.

Soil swelling: II, Swelling of soil in solutions of electrolytes; microscopic and X-ray investigations. D. I. SIDERI. *Soil Sci.*, **41** [4] 275–93 (1936).—Solutions of salt and of H_2SO_4 lower swelling, with the exception of 0.1 *N* and 0.5 *N* solutions of NaCl and $MgCl_2$. Parallel with the study of the swelling of soil in solutions of electrolytes, a study was made of the absorption of cations. The curve of absorption has an opposite trend to the curve of swelling. The curve of absorption may be regarded as the curve of the coagulation of the sol of the soil colloid. Microscopic investigation confirmed the method by which a sharp difference between structural and structureless soil was established on the basis of absorption of water and of inert liquids by soil. Microscopic investigation of swelling in solutions of electrolytes gives results coinciding with the values found for "swelling water" ("swelling solution") as an indicator determining the process of swelling in its proper quality. X-ray investigation of suspensions isolated from structural and structureless soils showed that they contain but slight amounts of crystalline substance, the prevalent mineral of which is quartz. Crystalline substance takes no part in the process of swelling. G.R.S.

Strontium. E. G. ENCK AND G. H. CHAMBERS. *Foote-Prints*, **9**, 11–19 (1936).—Celestite, natural strontium sulfate, from British deposits is the principal source of strontium. Valuable uses have been found for strontium salts in beet sugar, caustic soda, and steel processing, but the ceramic applications have been limited because there are no outstanding advantages over calcium and barium. A.P.

Structural and morphological relations between epidote and zoisite and between epidote and ardennite. H. STRUNZ. *Z. Krist.*, **92**, 402–407 (1935).—The crystallographic similarities in these minerals are described. H.I.

Structure of adsorption complexes in clays. R. H. J. ROBORGH AND N. H. KOLKMEIJER. *Z. Krist.*, **94** [1] 74–79 (1936).—On the basis of X-ray investigations it is probable that ion exchange in clays takes place at the surface of crystalline substances such as montmorillonite and that a colloidal hydrolysis film is responsible for the exchange. H.I.

Structures of some hydrates of sodium di-borate. W. MINDER. *Z. Krist.*, **92**, 301–309 (1935).—The lattice constants and space groups were determined for kernite, tinkalconite, and borax. H.I.

Synthetic emerald. H. ESPIG. *Z. Krist.*, **92**, 387–91 (1935).—Photomicrographs are given of small synthetic emeralds having the composition $3BeO\cdot Al_2O_3\cdot 6SiO_2$. H.I.

Tektite observed to fall in West Australia. E. S. SIMPSON. *Jour. Roy. Soc. W. Australia*, **21**, 37–38 (1935).—The first tangible evidence in our own time of the fall of the glassy body known as tektite (in Australia, australite) from the sky is given. The specimen weighs 31 g. and measures 48 x 23 x 20 mm. H.H.S.

Third study of chlorite. A. N. WINCHELL. *Amer. Mineralogist*, **21** [10] 642–51 (1936).—A revised diagram has been prepared showing the relations between variations in composition and in optic properties in the main chlorite system (antigorite-amesite-daphnite-ferroantigorite). The relations between optic properties and the various types of chlorite have been shown in another diagram. A new graph for the antigorite-amesite-kaemmererite system has been prepared. The effects produced on optic properties by oxidation of ferrous iron in certain chlorites have been expressed graphically. F.J.Z.

Unusual occurrence of myrmekite and its significance. E. S. HILLS. *Geol. Mag.*, **70**, 294–301 (1933).—A new occurrence of this quartz-feldspar intergrowth in an Upper Devonian toscanite rock in Australia is reported. It is produced by reactions in the solid state and develops in the post-solidification cooling stages or during metamorphism. W.D.F.

Zircon. H. C. MEYER. *Foote-Prints*, **9**, 1–9 (1936).—The Australian, Indian, and Brazilian sources of zircon ores are described. A.P.

BOOKS

Down to Earth. C. CRONEIS AND W. C. KRUMBEIN. Univ. of Chicago Press, Chicago, 1936. xvii + 501 pp., 64 plates. Price $3.75. Briefly reviewed in *Econ. Geol.*, **31** [6] 644–45 (1936).—The book is designed as a text that will be more interesting to the general reader than the conventional geology textbook. It will also be valuable as a supplementary college text. J.L.G.

Kieselguhr in Brazil. S. FRÓES ABREU. Published by the Instituto Nacional de Technologia, 1935. 34 pp., 20 figs. A. discusses diatomite in Brazil, indicating the principal deposits which have been discovered recently. Analysis and characteristics of the principal types of diatomite in Brazil are shown. There are deposits where diatomite is mixed with clays (Campos); other quite pure deposits are formed by fresh water diatoms. Others are formed of spiculas of sponges. A. K. SOARES

Klockmann's Textbook of Mineralogy (Klockmanns Lehrbuch der Mineralogie). PAUL RAMDOHR. 11th ed. Ferd. Enke, 1936. 638 pp. Price 34.00 Rm. Reviewed in *Tonind.-Ztg.*, **60** [33] 426 (1936).—The book is divided into general and special mineralogy, the latter being the most interesting. M.V.C.

Minerals of Franklin and Sterling Hill, Sussex County, N.J. CHARLES PALACHE. *U.S. Geol. Surv. Prof. Paper*, No. 180 (1935). vi + 135 pp., 199 figs., 19 plates, 1 table. Reviewed in *Econ. Geol.*, **31** [5] 531–32 (1936).—Over 140 minerals are described. Of these, 30 are known only in this locality. J.L.G.

Minerals Yearbook, 1936. U. S. Bureau of Mines. 1136 pp., 154 illustrations. Supt. of Documents, Govt. Printing Office, Washington, D. C. Price $2.00. The Minerals Yearbook provides in convenient form a comprehensive and accurate record of economic developments and trends in the mining industry of the U.S. for the information and use of producers and consumers of mineral commodities and of the general public. The factual data regarding the operation of the mineral industry of the U.S. in 1935 are presented and interpreted in this volume. The book is divided into four parts covering (1) survey of the mineral industry, (2) metals, (3) nonmetals, and (4) mine safety. R. A. Heindl

Mining operations in the Province of Quebec during 1934. A. O. Dufresne. *Ann. Rept., Quebec Bur. Mines*, **1934**, Part A, 202 pp. The report is statistical and descriptive, covering cement, clay products, feldspar, kaolin, talc, etc. A. H. Emery

Quartz, Feldspar, and Clays around Guanabara Bay. S. Froés Abreu. Published by the Instituto Nacional de Technologia, April, 1935. 51 pp., 8 figs. A. presents studies on the distribution and chemical composition of quartz, feldspar, and clays of Rio de Janeiro and its surroundings, materials which may supply the local ceramic plants. He deals especially with feldspar of Nictheroy and with several types of clay. Clays of the region are classified as (1) clays derived from the local decomposition of gneiss and granite, (2) sand clays of sediment, (3) clays derived from microsyenite, (4) mud clays, and (5) kaolins in primary deposits. The sand clays dispersed on lowlands are of the Pleistocene age and originate from gneiss and granites; in some places are quite pure clays which may be classified as sedimentary kaolins. Analyses of each type are presented as well as data on plasticity, shrinkage, melting points, etc. A. K. Soares

Structure of Crystals. Ralph W. G. Wyckoff. Supplement for 1930 to 1934 to 2d ed. American Chemical Society, Monograph Series No. 19A. Reinhold Publishing Corp., New York, 1935. 240 pp. Price $6.00. Reviewed in *Nature*, **137** [3463] 450 (1936); *Ind. Eng. Chem., News Ed.*, **13** [17] 360 (1935).—The book contains data on compounds whose structure has been investigated by the X-ray method in the years 1930 to 1934: 129 references to 1930 articles, 509 for 1931, 503 for 1932, 546 for 1933, and 362 for 1934. See *Ceram. Abs.*, **11** [2] 138 (1932). J.L.G. + F.G.H.

Talc and ground soapstone industry in 1935. Anon. *Bur. Mines Mineral Market Rept.*, MMS 472. 2 pp. Free. An advance summary is presented. R.A.H.

Chemistry and Physics

Absolute method of measuring attraction coefficients and magnetic susceptibilities of liquids. Thermomagnetic study of dissolved cerous salts. G. Dupouy and G. Haenny. *Jour. Phys. Radium*, **7** [1] 23–29 (1936).—A method of measuring simultaneously the attraction coefficient and magnetic susceptibility of liquids, derived from the cylinder method of Gouy, is described, and its application to the thermomagnetic study of paramagnetic substances in solution is outlined. F.P.P.

Accelerated method of determining calcium oxide in clinker. N. S. Kostzov. *Tzement*, **4** [2] 44 (1936).—Clinker in amount of 0.2 to 0.4 g. is dissolved for 2 min. in 5 to 7 cc. of HCl (concentration 1:2) with an addition of 2 to 3 drops of nitric acid and boiled 3 min.; 0 to 50 cc. of hot water and 10 cc. of 10% tartaric acid are added and boiled 1 min., 10 cc. of 10% oxalic acid being added while stirring. Ammonia is added afterward until an alkaline reaction appears. After 5 to 10 min. boiling, the liquid is filtrated through a filter of medium density, and the residue is washed out with hot water. After washing out, the calcium oxalate is dissolved in H_2SO_4(1:4) and titrated by $^1/_{10}$ *N* $KMnO_4$. The determination, with an accuracy of 0.1%, can be completed in 35 to 45 min. P.B. & E.S.

Action of light and electrons on silver halides. J. J. Trillat and H. Motz. *Jour. Phys. Radium*, **7** [2] 89–92 (1936).—The photographic emulsion of gelatin and silver bromide, sufficiently exposed to light to have attained the "solarized" condition, contains free silver in crystalline form; the amount of silver increases with exposure time as has been verified by X-ray spectrography. Using electron diffraction methods, an attempt was made to follow the formation of crystalline silver. Contrary to expectation, no free silver could be detected in formation, although the silver halide was observed to transform from the amorphous to the crystalline state. F.P.P.

Analytical separation of aluminum and titanium. A. Giammoña. *Giornale Chim. Ind. Applicata*, **16** [100] 500 (1934); abstracted in *Verre & Silicates Ind.*, **7** [21] 254 (1936).—The separation is based on the fact that the salts of titanium do not precipitate with ammonia in the presence of hydroxylamine, although the aluminum salts give a precipitate of aluminum hydroxide. After filtering and washing, the titanium is determined in the filtrate by ordinary methods. M.V.C.

Application of dibromo-oxyquinoline for determining small quantities of iron, titanium, and aluminium in mixtures. A. M. Zan'ko and A. J. Bursuk. *Zhur. Prik. Khim.*, **9** [5] 895–98 (1936).—A method of quantitative determination of $Al^{'''}$ by dibromo-oxine from a feebly ammoniacal solution has been developed. $Ti^{''''}$ can be quantitatively separated in the form of dibromo-oxyquinolate from an acid solution containing tartaric acid. $Fe^{'''}$ and $Ti^{''''}$ can be determined in the given succession by the aid of dibromo-oxyquinoline in the presence of tartaric acid and a changing acidity of the solution. The successful use of this method for the analysis of small quantities of $Fe^{'''}$, $Ti^{''''}$, and $Al^{'''}$ is due to a very small solubility of precipitates and their high molecular weight. P.B. & E.S.

Brownian movement of an ellipsoid: II, Free rotation and depolarization of fluorescence. Translation and diffusion of ellipsoidal molecules. Francis Perrin. *Jour. Phys. Radium*, **7** [1] 1–11 (1936).—Analytical study of the Brownian movement of rotation, given in previous work, is extended and applied to the calculation of depolarization resulting from rotation of molecules excited

by fluorescence emitted by ellipsoidal molecules in solution. Mathematical formulas and graphs are presented giving the values of the coefficient of diffusion for the revolving ellipsoids. F.P.P.

Cadmium yellow and cadmium red as pigments in the silicate industry. L. STUCKERT. *Farben-Ztg.*, Nos. 1 and 3 (1935); abstracted in *Glashütte*, **66** [25] 421 (1936).—Cadmium yellow comprises all colors based on cadmium sulfide, first of all CdS. Cadmium red is a derivative of CdS and is a mixed crystal, CdS/CdSe; its composition may vary within certain limits. Its color tone fluctuates between light orange and deep purple. Compositions used in practice are as follows: 2.04% Zn (3.04% ZnS), 2.15 Zn (3.21 ZnS), 68.90 Cd (64.00 CdS), 15.32 S, 13.63 Se (33.00 CdSe), 70.44 Cd (69.40 CdS), 16.44 S, or 11.08 Se (26.80 CdSe). M.V.C.

Change of inner structure of siliceous materials by heat treatment: II. T. NAKAI AND Y. FUKAMI. *Jour. Soc. Chem. Ind. Japan*, **39** [7] 228–29B (1936).—Tables show the effect of different agents, such as alkalis, copper oxide, borax, cobalt oxide, zinc oxide, chromic oxide, and lead oxide, on the conversion of quartz into cristobalite. For Part I see *Ceram. Abs.*, **13** [11] 294 (1934). M.V.C.

Chemical activity of silicic acid. W. N. KRESTINSKAJA AND O. S. MOLTSCHANOWA. *Kolloid-Z.*, **76** [1] 60–72 (1936).—Silica sols were titrated potentiometrically with copper sulfate, magnesium sulfate, sulfuric acid, etc. From the plotted curves and gravimetric determinations of Cu in the treated solutions, it is shown that at low temperatures silica sols do not react with electrolytes of these types. F.P.P.

Chemical and mineralogical investigation of barium aluminates. N. A. TOROPOV. *Compt. Rend. Acad. Sci. U.R.S.S.*, No. 2–3, pp. 147–49 (in German 150–51) (1935).—The microscopical investigation showed the presence of the following minerals in the fusion: (1) $3BaO \cdot Al_2O_3$ or $Ba_3Al_2O_6$; it could not be fused on account of intensive hydration in the air. It had a tabular and spherulitic crystalline structure, a refractive index of n (mean) = 1.735, and birefringence $Ng - Np = 0.009$. Specific weight determined in toluidine at 25°C; $d^{4°}_{25°} = 4.54 \pm 0.01$. (2) $BaO \cdot Al_2O_3$ or $BaAl_2O_4$: crystallized in irregular or hexagonal grains of the cubic system. No adherence. Refractive index $n = 1.683 \pm 0.002$. Easily soluble in water, not hygroscopic. Specific gravity $d\,^{4°}_{25°} = 3.99 \pm 0.03$. Fuses at 1820° ± 20°. (3) $BaO \cdot 6Al_2O_3$ or $BaAl_{12}O_{19}$. Forms hexagonal crystals. Good adherence along the base. Refractive index $n_e = 1.694 \pm 0.002$, $n_\omega = 1.702 \pm 0.002$, $N_e - N_\omega = 0.008$. Insoluble in concentrated HCl and fused soda. Specific weight $d^{4°}_{25°} = 3.69 \pm 0.01$. On account of the vicinity of the crystalline lattice to $\beta - Al_2O_3$, this compound can be regarded rather as a solid solution of BaO in Al_2O_3. P.B. & E.S.

Cobalt macrodetection. F. P. DWYER. *Jour. Australian Chem. Inst.*, **3** [8] 239–44 (1936).—The Vogel test (blue with thiocyanate) is preferred to any other. Fe interference (red) can be removed by $NaAmHPO_4$ or $KAmF_2$. Hg interferes by precipitating Co mercurithiocyanate. The sensitivity of the Vogel test is 0.5 gamma Co. H.H.S.

Coherence of vibration in optical resonance. P. SOLEILLET. *Jour. Phys. Radium*, **7** [2] 77–83 (1936).—Polarization of light resulting from the optical resonance of atoms in a zero field can only be interpreted by assuming a certain intervibrational coherence which, in the presence of a field, constitutes the diverse decomposing rays of a single ray of hyperfine structure. A theory and equation are derived, mathematically, to express this coherence, and its application to feeble fields is illustrated. F.P.P.

Collation of experimental data: XXXIV. A. ALISON. *Glass*, **13** [7] 288 (1936).—A. gives the correlation of causal connections. **XXXV.** *Ibid.*, [8] 354; for Parts **XXXII–XXXIII** see *Ceram. Abs.*, **15** [10] 313 (1936). M.C.S.

Conductivity of quartz at high temperatures. E. DARMOIS AND R. RADMANECHE. *Jour. Phys. Radium* (Suppl.), No. 382, p. 17S (1936).—The conductivity of quartz at elevated temperatures was studied (1) by using piezoelectric quartz in feeble currents and (2) by the method of constant deviation in strong currents. Up to 230° to 250°C, the semilogarithmic relation of Joffe applies; beyond this, the current increases too rapidly for his equation to be valid. Different crystals of quartz are shown to vary in conductivity by factors of 1 to 20; two surfaces in the same crystal show the same conductivity. The curve of rising temperature does not coincide with that of the falling temperature. F.P.P.

Corrosion of different modifications of silica by chlorine at high temperature. P. P. BUDNIKOV AND E. I. KRETCH. *Chim. & Ind.*, **36** [3] 469–71 (1936).—The action of chlorine between 700 and 1150° on silica gel, amorphous silica residual from the analysis of silicates, rock crystal, and fused quartz was studied. Rock crystal and fused quartz noncalcined, and silica gel and calcined amorphous silica begin to react with chlorine in a porcelain boat at 900 to 950°. The action of chlorine at 1100 to 1150° in the presence of carbon on the above modifications and the sand of Tchasov-Yar, cristobalized or noncristobalized, was studied. It was found that the addition of carbon increased the loss due to chlorination in all modifications of silica. The preliminary calcination of silica gel, amorphous silica, rock crystal, and fused quartz lowers their activity toward chlorine. M.V.C.

Critical potentials of secondary emission. R. WARNECKE. *Jour. Phys. Radium*, **7** [7] 318–20 (1936).—W. has found, for several metals, a certain correlation between values of critical potentials observed in the secondary emission curves and the corresponding values at the energy levels of the external orbits. The arrangement of the atoms rather than their constitution is believed to be the major clue to clarification of secondary emission phenomena. F.P.P.

Crystal structure of low cristobalite, SiO_2. W. NIEUWENKAMP. *Z. Krist.*, **92**, 82–88 (1935).—X-ray investigation by rotation photographs of natural, twinned, low cristobalite show that it is similar in its trapezohedral symmetry to low quartz. In the bonds in the Si-O tetrahedra it is very like high cristobalite. The tetrahedra have undistorted forms but are somewhat rotated from the ideal positions. H.I.

Crystal structure of low quartz, SiO_2, and aluminum ortho-arsenate, $AlAsO_4$. F. MACHATSCHKI. *Z. Krist.*, **94** [2–3] 222–30 (1936).—Corrections in the structural ele-

ments of low quartz are made, and the close relationship with the structure of $AlAsO_4$ is pointed out. H.I.

Crystallization of pyroxene and hornblende from artificial silicate melts. D. P. Grigoriev and H. W. Isküll. *Zentr. Mineral. Geol. A*, No. 3, pp. 82–87 (1936).—Mixtures in the proportion $MgO:CaF_2:2SiO_2$ heated at 1250°C and slowly cooled from that temperature produced a mixture of crystals of pyroxene and hornblende. The pyroxene showed close similarities in optical properties to natural enstatite; the hornblende was not closely related to any known natural hornblende. The relation of these experiments to the pyroxene-hornblende reaction series in rocks is discussed. H.I.

Crystallographic structure of the isomorphous group (Si^{4+}, Ti^{4+}, Zr^{4+}, Sn^{4+}, Hf^{4+})P_2O_7. G. R. Levi and G. Peyronel. *Z. Krist.*, **92**, 190–209 (1935).—The crystal structure of the pyrophosphates, $Me^{IV}P_2O_7$ with Me^{IV} = Si, Ti, Sn, Zr, and Hf, was determined to elucidate the configuration of the radical (P_2O_7). The lattice constants and calculated densities for the five phosphates are given. H.I.

Dendritic growth of crystals. A. Papapetrou. *Z. Krist.*, **92**, 89–130 (1935). H.I.

Derivatives of ferric oxide and their structures. S. Goldsztaub. *Bull. Soc. Franç. Minéral.*, **58** [1–2] 6–76 (1935).—Studies of natural hydrated ferric oxides show that all have the composition $Fe_2O_3 \cdot H_2O$ with two forms, goethite and lepidocrocite. Goethite's structure is a repetition of the structural unit FeO·OH, no H_2O groups being present. FeOCl, when heated with H_2O, is transformed into lepidocrocite without losing transparency or its original form. The structures of FeOCl and lepidocrocite are very similar, lepidocrocite being composed of the structural unit FeO·OH with a different atomic arrangement from goethite. H.I.

Determination of ferrous iron in refractory silicates. Anon. *Jour. Roy. Soc. W. Australia*, **20**, 165–99 (1934).—The resistance of certain minerals such as tourmaline to acid decomposition by the HF-H_2SO_4 method makes this process unsatisfactory. A number of fluxes (KOH, NaOH, KF, NaF, KHF_2, CaF_2, borax) was investigated; ultimately, good results were obtained by fusion with sodium metafluoborate, $2NaF \cdot B_2O_3$. The preparation and analysis of fluoborates is described, and their constitution is discussed. H.H.S.

Diffusion of light by fluctuations of molecular field and critical opalescence. A. Rousset. *Jour. Phys. Radium*, **7** [2] 84–88 (1936).—The polarization factor of light diffused at 90° from the incident direction for 4 binary mixtures of organic liquids is measured. In contrast to previous findings of Audant and Rocard, it is shown that, as the critical temperature of complete miscibility is approached, the polarization factor diminishes, reaches a minimum of the order of 0.005, and increases rapidly in the neighborhood of the critical point. The phenomenon is explained by presuming a secondary diffusion, partially depolarized, the intensity of which grows more rapidly than that of the primary diffusion. F.P.P.

Effect of heat on the optical orientation of plagioclase feldspars. C. T. Barber. *Mineralog. Mag.*, **24** [154] 343–52 (1936).—It is concluded that there is little or no effect upon the optical orientation of heating plagioclase feldspars at 1000°C for 200 hr. H.I.

Electrical conductivity of zeolites. B. Gross. *Z. Krist.*, **92**, 284–92 (1935).—Measurements of conductivity of zeolites show that Ohm's law is valid for only short periods of current application. With longer applications and with constant voltages greater than 3000/cm., the current strength increases. Hysteresis breaks occur in the current-voltage curves over long periods. H.I.

Electrolyte coagulation of Prussian blue. E. L. Lederer. *Kolloid-Z.*, **76** [1] 54–60 (1936).—Investigation of the electrolyte coagulation of Prussian blue, using salts of different types, with sol concentrations ranging from 1.5 to 10 g./liter, showed the validity of Ostwald's activity-coefficients principle. Prussian blue sols obey Burton's rule, for which an empirical formula is derived. F.P.P.

Electronic semiconductors. G. Llaudrat. *Jour. Phys. Radium*, **7** [7] 297–304 (1936).—The electron theory of metals has introduced physical conceptions not limited to the problem of metallic conduction but applied, wherever possible, to the motion of electrons within any solid material. L. discusses theoretically the factors affecting "conduction" by photoelectric means, differentiates between ionic semiconductivity and electronic semiconductivity, correlates temperature and conductivity, and indicates the importance of surface and subsurface contamination. An attempt is made to reconcile theory and experimental results. F.P.P.

Fiducial argument in statistical inference. R. A. Fisher. *Ann. Eugenics*, **6**, 391–98 (1936). H.H.S.

Inner structure of high-aluminous porcelains and refactory materials. T. Nakai and Y. Fukami. *Jour. Soc. Chem. Ind. Japan*, **39** [8] 251–52B (1936).—Chemical and physical investigations of high-aluminous porcelains and refractory materials are briefly discussed. M.V.C.

Investigation of the viscosity of suspensions and solutions: VII, Viscosity of globular suspensions in Poiseuille currents. R. Simha. *Kolloid-Z.*, **76** [1] 16–19 (1936).—The Poiseuille current is resolved into two parts. The first consists of a translatory component, representable quadratically, while the second is linear and corresponds to the primary current examined by Einstein. Modification of the first components of the current shows that these produce no linear contribution to viscosity; this is true also for ellipsoids. Einstein's formula $\eta = \eta_0 (1 + 2.5c)$ applies for globular suspensions. For Parts I–VI see *Ceram. Abs.*, **15** [7] 220 (1936). F.P.P.

Ionization of dielectric liquids and its application to cosmic rays. M. C. Bialobrzeski. *Jour. Phys. Radium*, **7** [8] 329–36 (1936).—Recent observations on the ionization of dielectric liquids belonging to the hydrocarbon series are presented. Precise measurements of mobility and coefficient of recombining were obtained by X-rays. The relation between the mobility, μ, and the viscosity coefficient, η, is of the form $\mu = A\eta^{-1/2}$. F.P.P.

Method for the determination of fluorine. S. Shinkai. *Jour. Soc. Chem. Ind. Japan*, **39** [5] 162B (1936).—The method is based on the fact that many fluorides are decomposed by the action of concentrated sulfuric acid and silica, and the fluorine liberated as SiF_4 is absorbed in pow-

dered NaF: $2NaF + SiF_4 = Na_2SiF_6$. The amount of fluorine in samples of CaF_2 is shown in a table. M.V.C.

Microcrystal reactions with sodium diethyldithiocarbamate. JULIUS GRANT AND F. A. MEGGY. *Analyst*, **61** [723] 401–402 (1936).—Salts of Cd, Hg, Bi, Mn, Pb, Zn, Sr, Co, Ni, Fe, and Cu were examined for their ability to crystallize under the microscope with the reagent. Sb and Bi only gave unsatisfactory oily drops instead of crystals. H.H.S.

NaCl structure of the compound Li_2TiO_3 and its solid solution with MgO and $Li_2Fe_2O_4$. E. KORDES. *Z. Krist.*, **92**, 139–53 (1935).—One form of the compound Li_2TiO_3 is analogous in its NaCl structure to the isotropic form of $Li_2Fe_2O_4$. The lattice constants, density, and refractive index of the isotropic form of Li_2TiO_3 were determined. The observed intensities of the X-ray pattern agree well with the calculated on the assumption of statistical distribution of the Li^{+1} and Ti^{+4} ions. Li_2TiO_3, unlike other alkali titanates, is very resistant chemically. At high temperatures, the isotropic form inverts to a birefringent form. Li_2TiO_3 forms a complete series of solid solutions in binary and ternary mixtures with MgO and $Li_2Fe_2O_4$, members of the series having lattice constants with linear relations to those of the end members. Refractive indices, densities, and lattice constants for the solid solution series are given. All three end members have NaCl structures. The system is of technical importance in the manufacture of very refractory crucibles, etc., in the possible reduction of excessive expansion of MgO by substitution of small amounts of these isomorphous components. H.I.

Photoelectric absorptiometer. ADAM HILGER, LTD. *Jour. Sci. Instruments*, **13** [8] 268–69 (1936).—The instrument described can be used in chemical analysis to do the work of a colorimeter of the Duboscq type. This instrument, however, does not measure the colors of the substances (standard and unknown) but their relative light absorptions. Two photocells are employed. The principles and operation are described in detail. Prices: £46 for the instrument, £1 each for two glass cells, £1 10s for a set of five pairs of glass filters. Illustrated. J.L.G.

Practical method of chromite analysis. M. BERTHET. *Monit. produit chim.*, **18** [204] 3–4 (1936); abstracted in *Chem. Zentr.*, **ii**, 1032 (1936).—The finely powdered sample in amount of 0.5 g. is heated to dark red with 5 or 6 g. Na_2O_2; it is heated again, decomposed with Na_2CO_3, and dissolved in water. Na_2O_2 (1 g.) is added to the solution, and then some $(NH_4)CO_3$; the whole is boiled for 20 min. and filtered. The filtrate is treated with 20 g. NH_4NO_3, evaporated to dryness, and treated with hot water; the SiO_2 and Al_2O_3 are filtered off. SO_4^{II} and Cr are determined as usual. SiO_2, Fe, Mn, Al, Ni, Ca, and Mg are determined as usual in the combined precipitates. M.V.C.

Precision measurements of lattice constants of silicon. M. C. NEUBURGER. *Z. Krist.*, **92**, 313–14 (1935).—Precision measurement of the lattice constant of specially pure silicon gave as average value, $a = 5.4173 \pm 0.0005$ Å at 20°C. H.I.

Problem of comparing results of two experiments with unequal errors. H. FAIRFIELD SMITH. *Jour. Australian Council Sci. Ind. Research*, **9**, 211–12 (1936).—Equations are given for the degrees of freedom so that R. A. Fisher's z tables can be used. See "Fiducial—" this issue, p. 44. H.H.S.

Reactions in the solid state: II. R. JAGITSCH AND A. MASCHIN. *Monatshefte Chem.*, **68** [2] 101–108 (1936).—The Hahn emanation method was used to study the solid state reactions between CuO and Fe_2O_3 in forming copper ferrite. R.F.R.

Reactions in the solid state at high temperatures: III, Heterogeneous equilibrium in systems which are allied with gas evolution. WILHELM JANDER. *Z. anorg. allgem. Chem.*, **168** [2] 113–24 (1927). **IV, Compounds formed by reactions between basic and acidic oxides and carbonates and the nature of the form of the compound.** *Ibid.*, **174** [1] 11–23 (1928). **VI, Acidic exchange in some tungstates and molybdates.** *Ibid.*, **190** [4] 397–406 (1930). **VII, Reaction between niobium pentoxide and tantalum pentoxide with metallic oxides and alkali-earth carbonates.** WILHELM JANDER AND HERMANN FREY. *Ibid.*, **196** [3] 321–34 (1931); for Parts XI and XIII see *Ceram. Abs.*, **15** [8] 259 (1936). L.T.B.

Reciprocal rôle of alumina in reaction series. ALFRED BRAMMELL. *Mineralog. Mag.*, **24** [154] 363–66 (1936). H.I.

Relation between adhesion of microscopic particles and activity coefficients of the electrolyte. A. v. BUZAGH. *Kolloid-Z.*, **76** [1] 2–9 (1936).—The validity of W. Ostwald's activity-coefficients principle is established by studying the adhesion of microscopic particles to a wall. It is shown that the size of the single coefficient of the predominating ion is related to the influence of neutral salts on the adhesion. Several suspensions of quartz particles in salt solutions were studied. F.P.P.

Research on positon emission. S. DE BENEDETTI. *Jour. Phys. Radium*, **7** [5] 205–10 (1936).—Using the trochoidal method, the production of pairs (positons and negatons) as an effect of the energy materialization of radioactive emanation is investigated. In general, the results are in accord with theory; the proportionality of the emission to the square of atomic number and the preponderating emission due to gamma rays have been verified. Positons are strongly emitted from a source of Th (B + C). F.P.P.

Sorption of gases by solids. H. W. MELVILLE. *Sci. Progress*, **31** [12] 103–107 (1936).—M. reviews a new technique by J. K. Roberts for experimentation on the mode of formation and the nature of films produced when gases interact with solids. H.H.S.

Specific heat of liquids and their constitution. L. BRILLOUIN. *Jour. Phys. Radium*, **7** [4] 153–57 (1936).—A chiefly mathematical theoretical discussion of the thermal properties of liquids in relation to their atomic and molecular structure is presented. F.P.P.

Specific reagents for tin: dimercaptobenzenes and benzene-*o*-dithiols. R. E. D. CLARK. *Internat. Tin Council Tech. Pub.*, Nos. A40-41 (1936).—Sn can be detected and estimated colorimetrically by (1) the dimercaptobenzenes 4-methyl-1:2 and 4-chloro-1:2, which form a magenta red with Sn quite unlike the colors obtained with other metals, the nearest being a brick red with Bi; and (2) 1-chlorobenzene-3:4-dithiol, the preparation of

which as a reagent is described. See *Ceram. Abs.*, **15** [10] 315 (1936). H.H.S.

Structure of α-quartz. P'EI-HSIU WEI. *Z. Krist.*, **92**, 355–62 (1935).—The space group, inter-atomic distances, and angles between Si-O bonds for α-quartz are given. H.I.

Structure of baddeleyite, ZrO_2. ST. V. NÀRAY-SZABO. *Z. Krist.*, **94** [15] 414–16 (1936).—On the basis of comparison of computed intensities with data by Yardley (*Mineralog. Mag.*, **21**, 168 (1926)), some corrections of coördinates of ion positions of baddeleyite are made. H.I.

Structure-factor graphs for crystal analysis. W. L. BRAGG. *Nature*, **138** [3487] 362–63 (1936).—B. explains the use of contoured graphs in determining the configuration of atoms in crystals from X-ray data. More rapid analysis is claimed for the graphic method than for actual calculation. Illustrated by graphs and diagrams. J.L.G.

Structure of solid solutions of Fe_2O_3 in Mn_3O_4. E. J. W. VERWEY AND M. G. VAN BRUGGEN. *Z. Krist.*, **92**, 136–38 (1935).—A series of mixtures varying in composition from Mn_3O_4 to Mn_3O_4:$3Fe_2O_3$ were heated at temperatures between 900 and 1300°C, cooled rapidly, and examined by means of X-ray patterns. In mixtures with increasing Fe_2O_3, the tetragonal structure of Mn_3O_4 (hausmannite) is maintained with constant decrease of the axial ratio c/a and with constant decrease in the distance between doublet lines of certain zonal pairs until the doublets are merged into single lines at the composition with the atomic ratio Mn:Fe = 60:40 and the structure becomes cubic. The cubic structure is similar to that of the substance with the molecular ratio Mn_3O_4:$3Fe_2O_3$. H.I.

Structure of strontium and barium peroxides, SrO_2 and BaO_2. J. D. BERNAL, E. DJATLOWA, I. KASARNOWSKY, S. REICHSTEIN, AND A. G. WARD. *Z. Krist.*, **92**, 344–54 (1935). H.I.

Structure of vitreous BeF_2. B. E. WARREN AND C. F. HILL. *Z. Krist.*, **89** [5] 481–86 (1934).—An X-ray diffraction pattern of vitreous BeF_2 made with strictly monochromatic radiation is in satisfactory agreement with the calculated scattering curve based upon the random network picture of the vitreous state. BeF_2, SiO_2, and GeO_2 all have the same tetrahedral type of vitreous structure. H.I.

Surface strains of fused Al_2O_3 and La_2O_3. H. v. WARTENBERG AND E. SARAN. *Nachr. Ges. Wiss. Göttingen, Math.-Physik. Klasse* [Fachgr. 2], No. 2, pp. 65–71 (1936); abstracted in *Chem. Zentr.*, ii, 444 (1936). M.V.C.

Survey of magnetic materials in relation to structure. W. C. ELLIS AND E. E. SCHUMACHER. *Bell System Tech. Jour.*, **14** [1] 8–43 (1935). H.E.S.

Systems composed of silica, alumina, and magnesia: I. T. NAKAI AND Y. FUKAMI. *Jour. Soc. Chem. Ind. Japan*, **39** [7] 230–31B (1936).—The system SiO_2–Al_2O_3 was studied: (1) kaolin and alumina, (2) quartz and alumina, (3) natural minerals having the composition Al_2O_3–SiO_2. **II.** *Ibid.*, pp. 231–32.—The effect of temperature on the true specific gravity of the Al_2O_3–MgO system and the SiO_2–MgO system is shown in tables. The crystallization of cordierite was also studied. M.V.C.

Theory of atomic diffusion phenomena. L. GOLDSTEIN. *Jour. Phys. Radium*, **7** [6] 255–62 (1936).—Universally applicable analytic laws, valid for all neutral atoms, are derived for the coherent diffusion of electrons and of X-rays. F.P.P.

Thermodynamic potential at constant volume in solutions of strong electrolytes. J. YVON. *Jour. Phys. Radium*, **7** [2] 93–94 (1936).—The author derives, mathematically, the fundamental formula of the theory of electrolytes of Debye and Huckel, relative to the average partition of the ions of one component in the neighborhood of those of another in a solution that is thermodynamically in equilibrium. F.P.P.

Variation of piezoelectric modulus of quartz as a function of temperature. A. LANGEVIN. *Jour. Phys. Radium*, **7** [2] 95–100 (1936).—Based on Langevin's experiments, an attempt is made to explain apparent divergences in the results obtained by several experimenters, determining the variation with temperature of the piezoelectric modulus of quartz. By using a Curie type quartz dispositive L. claims to have eliminated gross errors in his work. The variation of the modulus is found to be linear with temperature, and to be equal to 10% between 15° and 200°C. F.P.P.

Viscosity of lime silicates, lime ferrites, and basic open-hearth slags up to 1625°. KURD ENDELL, GÜNTHER HEIDTKAMP, AND LUDWIG HAX. *Arch. Eisenhüttenwesen*, **10** [3] 85–91 (1936).—The relation temperature-viscosity in the systems CaO–SiO_2, and CaO–Fe_2O_3, and the effect of increasing silica content in lime ferrites CaO–Fe_2O_3 were measured in neutral and oxidizing atmospheres up to 1625°C. No conclusion could be arrived at with respect to the occurrence of compounds in the liquid state of these systems and as to the degree of viscosity. The most fluid slag was that containing the least silica. The degree of viscosity increases considerably in all cases between 1450 and 1625°C. M.V.C.

BOOKS AND BULLETINS

Annual Reports on the Progress of Chemistry for 1935: Vol. XXXII. Chemical Society, London, 1936. 527 pp. Price 10s 6d. Briefly reviewed in *Nature*, **137** [3476] 969 (1936); *Jour. Amer. Chem. Soc.*, **58** [6] 1066 (1936).—The different phases of chemical progress in 1935 are presented. J.L.G. + F.G.H.

Annual Tables of Constants and Numerical Data, Chemical, Physical, Biological, and Technological. Vol. X (1930), Part II. Published under the Patronage of the International Union of Chemistry. McGraw-Hill Book Company, Inc., New York, 1936. Two parts. 1800 pp. Price (for subscribers), cloth, $20.00. Reviewed in *Jour. Amer. Chem. Soc.*, **58** [7] 1319 (1936). F.G.H.

Petrography and X-rays (Pétrographie et rays X). B. BRAJNIKOV. Hermann, Paris. 39 pp. Price 12 F.—X-ray investigations are now applied to heterogeneous bodies, particularly to rocks. B. gives a short description of the numerous ways to identify rocks: optical, chemical, and mechanical. The shortcomings of these processes are exposed. In 1930, Sachs and Sander modified the techniques elaborated by Laue, Bragg, Debye, Scherrer, and Hull for use in petrography. A set-up allows a translation of the lamella; X-rays are reflected and give a surface pattern characterizing the rock texture. Recent developments show a possibility of determining

the crystallography of submicroscopic particles and their number. F.E.V.

Physical constants of pure metals: I–II. NATIONAL PHYSICAL LABORATORY. H. M. Stationery Office, London, 1936. 27 pp. Price 6d. Pure metals specially prepared in the laboratory are dealt with, and results on metals procured from outside sources are given. Data are given for melting points, latent heats of fusion, specific heats, thermal conductivities, and coefficients of expansion. H.H.S.

PATENTS

Barium fluosilicate. F. C. CARLSON (Grasselli Chemical Co.). U. S. 2,058,664, Oct. 27, 1936 (March 24, 1934). In a process of making barium fluosilicate, the steps comprise reacting barium sulfide with fluosilicic acid by adding the barium sulfide to a fluosilicic acid solution, such quantities of barium sulfide and fluosilicic acid being used as to leave an excess of neither, physically separating silica together with the solution from the precipitated product, and drying the product.

Improved method in the manufacture of sodium aluminum sulfate. A. H. FISKE AND C. S. BRYAN (Rumford Chemical Works). U. S. 2,055,283, Sept. 22, 1936 (March 20, 1935).

Method of examining the state of crystallization of calcined aluminum oxide. REINHOLD REICHMANN (Siemens & Halske, A.-G.). U. S. 2,058,178, Oct. 20, 1936 (Jan. 3, 1933). A method of examining the state of crystallization of calcined alumina comprises dissolving alizarin red in water, immersing the substance to be tested into the solution, stirring the solution so long as to cause a coloring of the substance to be tested, removing the solid parts from the solution, drying them, and testing microscopically the intensity of the coloring.

Method of producing sodium aluminum sulfate. A. H. FISKE AND C. S. BRYAN (Rumford Chemical Works). U. S. 2,055,284, Sept. 22, 1936 (March 20, 1935).

Process for making artificial cryolite. GANT GAITHER. U. S. 2,058,075, Oct. 20, 1936 (June 9, 1934). In the process of simultaneously manufacturing artificial cryolite and sodium fluoride, the steps comprise adding to an aqueous solution of sodium aluminate a quantity of sodium hydroxide in excess greater than the correct excess necessary to completely react in the succeeding step with hydrofluoric acid to produce cryolite and water, and treating the mixture with the correct proportion of hydrofluoric acid to co-produce cryolite, sodium fluoride, and water, and separating the cryolite and sodium fluoride thus formed.

Process for the production of calcium aluminate and alumina. J. C. SÉAILLES. U. S. 2,055,947, Sept. 29, 1936 (Nov. 2, 1934). The cyclic process comprises the separation of successive batches of convenient amount from a mass of crude material containing calcium aluminate, subjecting each batch, separately, at suitable intervals of time, to an aqueous liquid which is a solvent of calcium aluminate, freeing the resulting solution of calcium aluminate from the undissolved residue, causing separation of calcium aluminate from the solution by raising its p_H to a suitable degree by the addition of milk of lime thereto, submitting the calcium aluminate so separated to the action of a solution of sodium carbonate whereby a precipitate of calcium carbonate and a solution of sodium aluminate are formed, separating the solution and saturating it with carbon dioxide whereby a precipitate of alumina and a solution of sodium carbonate are obtained, the milk of lime, the carbon dioxide, and the sodium carbonate being by-products from other batches of the crude material containing calcium aluminate, whose treatment by this process has been so managed as to produce these by-products at the proper time for their use as reagents.

Process for reduction of silicates other than alkaline earth metal silicates and production of alloys of aluminium. G. N. KIRSEBOM (Calloy, Ltd.). U. S. 2,054,427, Sept. 15, 1936 (Dec. 7, 1933). A process for the manufacture of aluminium silicon alloys comprises the steps of heating china clay in a molten bath of aluminium below the surface thereof, without the addition of fluxes or materials which will form molten fluxes or slags, while the aluminium is in substantial excess of that required to combine with the oxygen of the added material, thereby to form a molten aluminium-silicon alloy and an infusible dross containing alumina, and thereafter separating the molten alloy from the infusible dross.

General

Automatic mechanical gas producers. A. E. GIBSON. *Steel*, 97 [Nov. 4] 43–45 (1935).—A new high-capacity, automatic gas producer using welded, low-alloy, high-tensile, corrosion-resistant steel is illustrated and described. The new producer affords maximum capacity of gasification with minimum operation expense. The upkeep cost is low which justifies the use of high-strength, lightweight, corrosion-resistant steels. H.E.S.

Automatic underfeed stokers. C. S. DARLING. *Power & Works Engr.*, 31, 290–92 (1936).—The installation and operation of underfeed stokers are discussed. F.P.P.

Boiler in the works. ANON. *Power & Works Engr.*, 31, 264–65 (1936).—A brief discussion of the comparative efficiencies of boilers in general is presented. F.P.P.

British architects build a palace. G. GWENNET. *Clarté*, 8 [2] 1–5 (1935).—Members of the Royal Institute of British Architects are celebrating the centenary of the Institution. A detailed description of the new building is given. Illustrated. R.W.D.

Ceramic industry of Japan. ANON. *Japan-Manchoukuo Yearbook*, p. 409 (1936).—In 1933 there were 3355 factories making pottery, glass, cement, and enameled ware, this figure being 4.7% of the total number of factories. Operatives numbered 71,195, 3.8% of the total. Output was valued at 220.7 million yen; raw materials consumed amounted to 59.7 million yen. Wages averaged 14 sen/hr. and amounted to 28.2 million yen. The average fixed working day was 10 hr., the actual average being 9.02. Exports were one-third of the total production, the U. S. A. being the largest importer. H.H.S.

Ceramic problem of Puerto Rico. ANTONIO R. ALONSO. *Corriere Ceram.*, 17 [6] 191–93 (1936).—The exploitation of local raw materials, which the country possesses in amounts sufficient for local consumption, and the prepa-

ration of technicians, artists, and workmen is being undertaken to build up the ceramic industry of Puerto Rico which now imports all ceramic ware. M.V.C.

Controlling dust in cement plants through exhaust systems: I–III. W. O. VEDDER. *Concrete* [Cement Mill Ed.], **44** [8] 35–37 (1936).—V. outlines industrial dust control. The dust can not be prevented; it must be controlled. The exhaust system has more general application than any other method. There are three parts to a dust control system, the exhaust hoods and piping, dust collectors, and exhauster. Dusty operations should be as nearly closed in as possible, and when this is not possible a hood should be used. The hood must be designed carefully and located close to the dust source. The air velocity from the hood at the dust source must be great enough to overcome any counter motion. Piping lengths and number of bends should be kept small by keeping dust-producing operations close together. Often several small exhaust systems are better than one large one. The average velocity of the air in the pipes should be 3000 to 4000 ft.-min. to carry dust without settling. A system should be designed to provide for any necessary later expansion. Specifications for exhaust-system piping are included. **IV.** *Ibid.*, [9] 38–41.—V. describes and criticizes various types of dust-collecting equipment including (1) settling chamber, (2) centrifugal or cyclone collector, (3) baffle-type collector, (4) fan-type centrifugal collector, (5) wet- or washer-type collector, (6) electrical precipitator, and (7) cloth-type filter. All except (6) and (7) take out only relatively coarse particles and (6) is too expensive. Considering everything, (7) is the best and is described in most detail. The measure of efficiency of any dust collector should be based on the dust left in the air, and not on that collected. **V–VI.** *Ibid.*, [10] 38–40.—The size of the exhauster is determined by the total volume of air to be handled, plus 10% allowance for leakage, and by the total resistance of the system. When the dust goes through the fan, exhausters are of the steel plate planing mill type; with clean air through the fan, more efficient fans, similar to ventilating fans, are used. These fans are driven by motors, with multiple V-belt drive predominating. Installations should be on a firm foundation and protected from the weather. Dust sampling, volumetric testing, and velocity determinations should be done simultaneously by a competent person as a check on the system. Static suction tests are of questionable value but may serve as an index. Frequent and regular check tests should be made. The system should be operated properly, and careful inspections should be made periodically of hoods and connections, piping, dust settlement, dampers, supports, suction, volume, exhauster housing, wheel, bearings, and speed. With cloth filtering systems, the cleaning and emptying of collectors, resistance, cloth shaker, dust leakage, collector casing, hopper valve, and timing and control apparatus should also be inspected. W.D.F.

Cylindrical or water-tube boilers. ANON. *Power & Works Engr.*, **31**, 270–71 (1936).—No general ruling is available to indicate a proper choice between cylindrical and water-tube boilers. F.P.P.

Danger of soft water. F. J. MATTHEWS. *Brit. Clayworker*, **45** [533] 173–74 (1936).—M. points out that the idea held by many engineers that soft waters are corrosive is erroneous and is due to lack of distinction between the merits of a properly softened water and the undoubted dangers of the use without treatment of a naturally soft water. He discusses the necessity of removing dissolved gases such as oxygen and carbon dioxide. R.A.H.

Economical heat transfer. W. SEIFERT. *Brennstoff & Wärmewirt.*, **18** [1] 6–9 (1936).—A spirally constructed heat exchanger is described and illustrated, and many performance data in terms of heating surface and mass of liquid are tabulated. With rates of flow of 1.5 to 2 m./-sec., heat transfer values of 2000 to 3000 cal./m.²h. °C were obtained. F.P.P.

Electrolytic measurement of corrosiveness of soils. I. A. DENISON. *Jour. Research Nat. Bur. Stand.*, **17** [3] 363–87 (1936); R.P. 918. Price 5¢.—The electrolytic behavior of steel in contact with 47 soils of known corrosiveness was studied, and the results are reported. R.A.H.

Enamelware industry of Japan. ANON. *Japan-Manchoukuo Yearbook*, p. 408 (1936).—In 1933, 67 factories employing 4175 operatives produced enameled ware valued at 12.3 million yen. H.H.S.

Estimation of lead in urine. F. MORTON. *Analyst*, **61** [724] 465–71 (1936).—By using dithizone as reagent, it was found that persons who have had no industrial connection with lead may average 0.04 (0.0 to 0.11) mg. Pb per liter, and 0.05 (0.0 to 0.12) per 24 hr. H.H.S.

Federal power and mineral industries of the western states. JOHN WELLINGTON FINCH. *Mining Congress Jour.*, **22** [10] 13 (1936).—F. discusses the influence of hydroelectric power from federal water-power developments in the western states upon existing and new mineral industries. Bureau of Mines studies of the question are reviewed, and the production of manganese, ferro chromium and chromium, magnesium, antimony, tungsten and other nonferrous metals, refractories, fused silica, glass, porcelain, phosphates, and other chemical products is considered. G.T.

Fuel costs for central-heating plants. B. FRISBY. *Power & Works Engr.*, **31**, 293–94 (1936).—Comparative data on efficiencies and on fuel, labor, and maintenance costs of hand- and mechanically-fired coal, hand- and mechanically-fired coke, mechanically fired oil and gas, and electricity are listed and discussed. Calorific considerations are shown to be insufficient as bases for judgment. F.P.P.

Glass, ceramic, and cement industries in Poland in 1934. CONSTANTIN KOWNACKI. *Chim. & Ind.*, **34** [5] 1217–20 (1935).—In the glass industry in 1934, the difficulties arose from the large number of new glass plants and the competition of small plants, especially for window and table glass. Bottle glass production decreased. The production of brick rose but the price went down; factories were working only part time. The same was true of porcelain and faience ware. In the last ten years great progress has been made in the refractory industry, but there is still a need for specialized technicians. M.V.C.

Glass industry of Japan. ANON. *Japan-Manchoukuo Yearbook*, pp. 408, 431–32, 488 (1936).—During the World War the glass industry of Japan multiplied eleven-fold. The glass-producing districts are Osaka, Fukuoka, Hyogo, Kanagawa, Tokyo, and Aichi; these six prefectures claim 96% of the total production. The largest firms are Asahi

Glass and Nippon Sheet Glass, their profits being 41 and 51% and their dividends 20 and 12%, respectively. In Dairen, Manchoukuo, is the Shoko Glass Co., which is under the joint control of Asahi Glass and the South Manchuria Railway. Since 1933, Japan has been the largest producer of sheet glass in the world, with the U. S. second and Belgium third. Japanese consumption of glassware, apart from sheet glass and bottles, is not large, because pottery is the older and more favored industry. In 1933, 564 factories employing 17,092 operatives produced glass valued at 54 million yen. Exports in 1934 were 19.5 million yen, of which British India took 5.7, Dutch Indies 2.0, U. S. A. 1.8, Straits Settlements 1.0, Philippine Islands 0.9, Australia 0.8, and S. Africa 0.8. Imports were 4.6 million yen of sheet glass, and 1.8 million yen of photographic dry plates. H.H.S.

Industrial materials in chemical apparatus, application of nonmetallic materials. FRITZ MILDEBRANDT. *Chem.-Ztg.*, **59** [53] 536–39 (1935).—Examples of stoneware, glass, quartz ware, and porcelain used in chemical apparatus and their properties are discussed in detail. M.V.C.

Inspection and tensile tests of some worn wire ropes. WALTER H. FULWEILER, AMBROSE H. STANG, AND LEROY R. SWEETMAN. *Jour. Research Nat. Bur. Stand.*, **17** [3] 401–51 (1936); R.P. 920. Price 10¢.—The authors tested 229 specimens taken from 79 worn wire ropes. These data indicate that the strength of worn ropes may be determined, with sufficient accuracy for deciding when the rope should be replaced, by measuring the length of wear on the outside wires and counting the number of broken wires. R.A.H.

International Art Exhibition at Sydney. ELEONORE LANGE. *Art in Australia*, **3** [64] 29–62 (1936).—Works of art from fourteen countries were assembled in Sydney from July to Sept., 1936, many of them being loaned by national governments. Ceramic pieces from Japan and Scandinavia are illustrated. H.H.S.

International Union of Chemistry. ALEXANDER SILVERMAN. *Bull. Amer. Ceram. Soc.*, **15** [10] 367–68 (1936).

Latest developments in the field of filters and diaphragms. HANS RUDOLF. *Chem.-Ztg.*, **60** [23] 235–38 (1936).—Filters made of ceramic materials and artificial resins and used not only for filtration but also for colloidal dispersion are described. A short discussion of the principles and work of diaphragms is given. M.V.C.

Meeting of Founder Societies of the American Institute of Physics. ANON. *Bull. Amer. Ceram. Soc.*, **15** [10] 372 (1936).

Meeting of the Saxonian group of the German Ceramic Society. HANS LEHMANN. *Sprechsaal*, **69** [8] 101–103 (1936).—A short discussion is given of papers read at the meeting of the Saxonian group of the German Ceramic Society at Meissen in January, 1936, including (1) "Mining ceramic clay by blasting," by Fr. Weichelt; (2) "Testing properties of clays and kaolins with the help of unit (standard) glaze," by Fr. Alzner; (3) "Modern filter and drying installation," by R. Fischer; and (4) "Theory of filter and drying process," by G. Wetzel. M.V.C.

Mineral content of the silicotic lungs of an earthenware worker. N. SUNDIUS, A. BYGDEN, AND T. BRUCE. *Trans. Ceram. Soc.*, **35** [4] 167–81 (1936).—The mineral content of the silicotic lungs of an earthenware worker engaged in the industry for thirty years was determined by decomposing the lung tissue at 70°C by H_2O_2 and examining the residue by means of the petrographic microscope. It was found that the dust was distributed fairly uniformly throughout the lungs and was made up of particles (whose average diameter was about 2 to 4 μ) identified as rutile, muscovite (sericite), kaolinite, quartz, flint, tourmaline, topaz, and feldspar, minerals occurring in the raw materials used in the manufacture of earthenware. The similarity between the lung dust and the dust from the workshops is shown by X-ray photographs. No change in the chemical composition of the dust in the lung with time was detected and it is pointed out that those ingredients of the raw materials are most dangerous which are inclined to produce finely divided and easily suspended particles. R.H.H.P., JR.

National Silicosis Conference outlines objectives. ANON. *Heating, Piping, & Air Conditioning*, **8** [8] 438 (1936); *Amer. Enameler*, **9** [3] 20 (1936).—A brief report is given of the National Silicosis Conference called by the U. S. Department of Labor. Committees were appointed to report on (1) prevention of silicosis through medical control, (2) prevention through engineering control, (3) economic, legal, and insurance phases, and (4) regulatory and administrative problems. J.L.G. + J.H.S.

Oil reclamation. ANON. *Trade & Eng.*, **38**, 8 (1936).—A recommendation that the users of lubricating oil "reclaim," *i.e.*, treat and reuse, it is given. Half of the lubricating oil now used could be reclaimed whereas at present it is nearly all lost. The reclamation of oil from "engineer's waste" and "rags" is commended. Of the various methods mentioned, the one most strongly recommended is the use of a small centrifugal separator. A.B.S.

Porosity of materials as a factor of their impermeability to air. B. F. VASIL'EV AND P. BRILING. *Stroitel. Material.*, No. 3, pp. 49–57 (1936).—An investigation was made by passing air through a layer of small shot strewn on a metallic network. When the porosity of the layer is constant, the air permeability increases in proportion to the square of the diameters of the pores; in the case of different absolute porosities it is directly proportional to cross-sections determined as a function of porosity. Calculations can be made according to the formula:

$$\frac{Q}{Q_\delta} = \frac{\delta}{S} / 1 + \frac{\delta - S}{C} = Li$$

where Q_δ is air expenditure, δ is thickness of the layer (cm.), Q is air expenditure with a layer 5 cm. thick, and C is the deviation coefficient depending on the material used. P.B. & E.S.

Preparation of clays; scientific developments. MAURICE DÉRIBÉRÉ. *Brit. Clayworker*, **45** [534] 211–15 (1936).—In this treatise, account has been taken only of scientific aids applicable to practice in the direct domain of physical, chemical, or physicochemical operations. These aids enable the ceramic industry to gradually emerge from empiricism where it has long been confined. D. discusses, reviews, and shows the application to the ceramic industry of (1) colloids, (2) concentration of hydrogen ions and the rôle of the p_H, and (3) osmosis and electroösmosis. R.A.H.

Return of condensate from heating plants. K. S. LAURIE. *Power & Works Engr.*, **31**, 213–17 (1936). F.P.P.

Silicosis: causes, effects, prevention, predisposition. R. D. *Quarry & Roadmaking*, pp. 79–80 (March, 1936); abstracted in *Verre & Silicates Ind.*, **7** [22] 264 (1936).—Silica is the prime cause of this malady, the danger of which lies in the fact that its minute particles (the dangerous particles have a diameter less than 10 microns; optimum dimensions are between 5 and 0.5 microns) do not irritate the nose and throat during inhalation and do not cause discomfort for a long time. Silicosis often leads to tuberculosis. M.V.C.

Specially designed stokers permit economical use of low-grade coal. W. P. JONES. *Steel*, **97** [Sept. 16] 39 (1935). H.E.S.

Studies of the Geophysical Laboratory at Washington. TOM. BARTH. *Tek. Ukeblad*, **83**, 129–30 (1936); abstracted in *Chem. Zentr.* **ii**, 449 (1936).—B. gives a concise discussion dealing with silicate minerals and glass. M.V.C.

Studies in 1933 by the State Research Bureau for Silicate Industry of Brünn. O. KALLAUNER. *Erde & Stein*, **3**, 3 (1934); abstracted in *Sprechsaal*, **69** [31] 446 (1936).—Studies devoted chiefly to brick, sandstone brick, wall tile, stoneware tile, paving tile, cement and concrete materials, etc., are briefly discussed. Only eight abstracts are given. M.V.C.

Technique of the addition of barium carbonates. W. MARSCHNER. *Tonind.-Ztg.*, **60** [53] 658 (1936).—The use of a surplus addition of barium carbonate eliminates the necessity of weathering the clay mix. M.V.C.

Technique of barium addition. W. AVENHAUS. *Tonind.-Ztg.*, **60** [44–45] 551–53 (1936).—Barium carbonate, which is added to clay or ceramic mixes to eliminate the effect of water-soluble salts, must be dry, finely ground, and intimately mixed. The material treated with carbonate must be stored for at least six days so that the carbonate will have time to act and transform all soluble salts into insoluble salts. The amount of carbonate added is determined by the analysis of raw materials. M.V.C.

Technique and practice in the production of brick and lime: XXX. ALBERTO PELLACINI. *Corriere Ceram.*, **17** [4] 115–22 (1936).—P. deals with a school for brickmaking, a method of using raw and fired waste products of brickmaking, the polishing of fired brick, a comparison of prices, etc. For Parts **XIX–XXII** see *Ceram. Abs.*, **15** [2] 62 (1936). M.V.C.

Teeter condition. R. T. HANCOCK. *Mining Mag.*, **55**, 90–94 (1936).—H. discusses washing or beneficiating mineral deposits and practical applications to different forms of ore-separating machines. W.D.F.

Weights and measures of Japan. ANON. *Japan-Manchoukuo Yearbook*, (1936).—*Length:* 1 ri = 36 cho = 2160 ken = 2.4403 miles = 3.9272 km. *Capacity:* 1 koku = 10 to = 100 sho = 47.95389 liquid U. S. gallons = 1.80391 hectoliters. *Weight:* 1 kwan = 1000 momme = 8.26733 lb. avoirdupois = 3.75000 kg.; 1 kin = 160 momme = 0.6 kg. H.H.S.

BOOKS AND BULLETINS

Arthur D. Little (1863–1935). ANON. *Ind. Bull. Arthur D. Little, Inc.*, No. 103 (July, 1935).—The important achievements and high-lights in the life and career of Arthur D. Little are noted. H.E.S.

By-Products of the Inorganic Chemical Industry and Their Application (Abfallstoffe des Anorganisch-Chemischen Industrie und ihre verwertung). EMIL J. FISCHER. Theodor Steinkopff, Dresden, 1936, 156 pp. Price 10.00 Rm. Reviewed in *Tonind.-Ztg.*, **60** [62] 771 (1936).—F. discusses various waste products of the chemical industry, including the silicate and metal industries, and their uses. M.V.C.

Ceramic Industry of Saxony (Die Keramische Industrie in Sachsen). EBERHARD SCHILDE. Zahn & Jaensch, Dresden, 1936. 104 pp. Reviewed in *Sprechsaal*, **69** [27] 397–98 (1936).—The book deals mostly with the location of plants and deposits of raw materials. M.V.C.

Japanese Trade and Industry: Present and Future. MITSUBISHI ECONOMIC RESEARCH BUREAU. Macmillan & Co., 1936. 730 pp. Price 21s. Reviewed in *Mitsubishi Circ.*, No. 150, p. 1 (1936). H.H.S.

Method in Experimental Sciences (De la methode dans les sciences experimentales). HENRY LE CHATELIER. Dunod, Paris. 319 pp. Price 18 F. Reviewed in *Verre & Silicates Ind.*, **7** [16] 194 (1936).—L. supports the rules of the scientific method by facts from observation and personal study during the course of a career of 60 years. He shows that science was born out of the needs of industry and that the mutual support of pure and applied science is necessary for the progress of both. L. analyzes the conditions which a discovery must fill in order to be usable in industry; he discusses the discipline most favorable for different mental operations necessary for setting a scientific method to work, and gives the principles which should guide the teaching of higher technique for developing future heads of industry. M.V.C.

National Physical Laboratory Report for 1935. DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH. H. M. Stationery Office, London, 1936. 249 pp. Price 12s. Reports of studies made in the National Physical Laboratory in the fields of physics, electricity, radio, metrology, engineering, metallurgy, and aërodynamics are given. M.C.S.

Questions and Answers on Boiler Feed-Water Conditioning. J. F. BARKLY. Bureau of Mines Handbook. Superintendent of Documents, Government Printing Office, Washington. 121 pp. Price 20 ¢. R. A. HEINDL

Silicates of soda. ANON. *Philadelphia Quartz Co. Bull.*, No. 171; reviewed in *Ind. Eng. Chem., News Ed.*, **13** [22] 448 (1935).—The properties and analyses of various grades of silicate of soda are discussed, and recommendations are made for the grades to be used for particular industrial purposes. F.G.H.

Warmth Factor in Comfort at Work, a Physiological Study of Heating and Ventilation. ANON. *Medical Research Council, Ind. Health Research Board, Rept.*, No. 76. H. M. Stationery Office, London, 1936. iv + 110 pp., 1 chart. Price 2s. H.H.S.

PATENT

Method of making ceramic products. C. F. RAMSEYER (Chicago District Electric Generating Corp.). U. S.

2,055,706, Sept. 29, 1936 (June 6, 1932). A method of producing a ceramic product capable of resisting shrinkage and cracking when subjected to immediate high-temperature firing comprises collecting the coal-ash-dust particles suspended in the gases derived from the combustion of pulverulent coal, treating the particles to remove sulfur and any carbon present in excess of 2% in the fly ash therefrom, and admixing the particles with a binder comprising from 4 to 5% of bentonite clay.

ANNUAL MEETING SCHEDULE, AMERICAN CERAMIC SOCIETY

Time	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
Forenoon			General Session	Division Meetings	Division Meetings	Division Meetings Trips	Trips
Noon		Board of Trustees and Committee Luncheons	(1) School Reunions (2) Committee C-8	Division Luncheons	General Committee Business Luncheon Meetings		
Afternoon	Board of Trustees	3:00 p.m. Ceramic Educators	4:00 p.m. Fellow Business Meeting	Division Meetings	Division Meetings	Trips	Trips
Dinner				Keramos Dinner Meeting	Dinner Dance All Evening		
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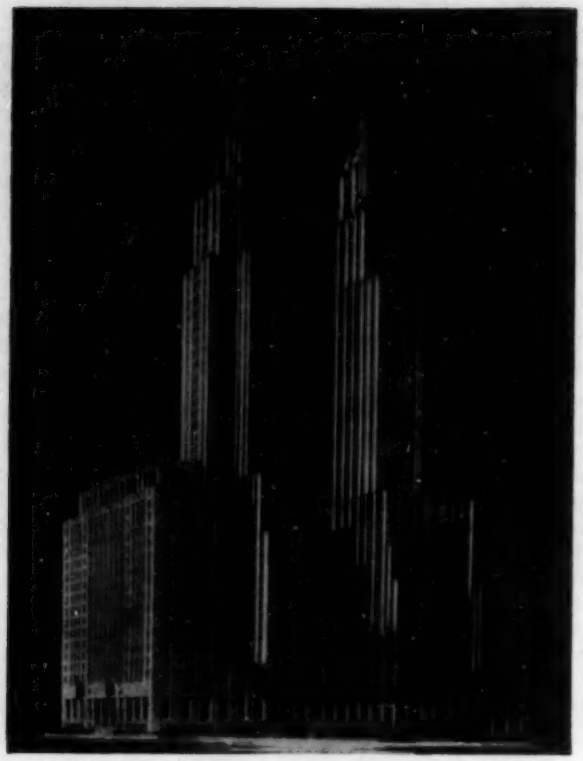

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